THE TELEGRAPHIC JOURNAL AND

ELECTRICAL REVIEW.

VOL. XXIV. APRIL 19, 1889. No. 595.

CONTENTS:

	PAGE
The City Lighting	437
The Efficiency of Methods of Artificial Illumination (*illus.*)...	440
Underground Conductors for Electric Installations	445
A Synthetic Study of Dynamo Machines (*illustrated*) ...	446
Electric Lighting Provisional Orders (*continued*)	448
Folkestone to be Lighted by Electricity	450
Storage Battery Patents	450
The Birmingham Electrical Exhibition	451
Notes	451
City Notes, &c. :—Indo-European Telegraph Company ...	454
Oriental Telephone Company	454
Traffic Receipts	454
Legal :—United Telephone Company *v.* New Telephone Co....	454
Reviews :—Glimpses of Feverland	455
Journal of the Institution of Electrical Engineers ...	455
Joseph Henry and the Magnetic Telegraph	455
Sprague Electric Road at Brockton, Mass. (*illustrated*) ...	455
Sprague Roads at Wilmington and Reading (*illustrated*) ...	457
Arc Lamps and their Mechanism (*concluded*)	458
Proposed Electric Lighting at Brighton	459
New Patents—1889	461
Abstracts of Published Specifications, 1888	462
Correspondence :—Some Electric Lighting Central Stations in Europe and their Lessons	463
The Northfleet Tramway	464

THE CITY LIGHTING.

WE understand that the specifications to which contractors for lighting the three selected City districts must conform are already in their hands. The clauses generally appear to be suggestive only, the details having to be filled in by the firms tendering for the work. One would have thought that after the time which has been spent upon this particular scheme, enough experience might have been gained by the technical advisers of the Commission of Sewers to enable them to draw up a specification, complete in all its details, and upon which contractors could directly base their estimates. As it is, we learn that the document is merely a compilation of clauses advising the parties tendering as to certain matters which they must bear in mind. They touch upon such topics as prices, times of lighting, alterations, interference with telephone and telegraph wires, breaking up streets, rights to supply private lighting, determination and terms of contracts, accidents, division of profits, power of the commission to acquire the undertaking, &c. There is ample subject matter in all these for the contractor to read, learn and inwardly digest, and then to seriously consider whether the game is worth the candle. The actual system of lighting and its many details is left to their own sweet wills, and it is to be feared that this will give rise to much complexity, and occasion the City engineer great mental perturbation.

It is difficult to understand why some definite instructions are not given in that clause drawing attention to disturbances between electric light, telephone, and telegraph wires. Surely it would not have been a difficult matter for Mr. W. H. Preece to have drawn up simple rules and regulations for the contractor's guidance? The mains, too, all of which must be laid underground, whether for public or private supply, may be removed at the option of the Commission, if it is thought that they are dangerous to public safety. Would it not have been more to the point to have decided this question previous to placing the conductors in position, considering that the contractor is bound to give the Commission every information as to the quality of the conductor, and in what way it is proposed to employ it?

The contractors will certainly have no easy time of it; they have to prepare ordnance maps, in which must not only clearly be shown the proposed positions of the electric lamps, but also those of the existing gas jets; they must enter into complete technical details of the lamps, and also demonstrate by plan and section the relative intensity of their lights compared with gas; the positions of mains and leads are to be distinctly shown; the lamps must always be in readiness for fogs, and ordinarily kept alight from sunset to sunrise; any alterations in the arrangements which the Commission may think necessary after the erection of the plant must be carried out, in one case at the cost of the contractor; the Commission is at all times empowered to test the mains in any manner deemed desirable; and, with a multiplicity of other items, those who tender will have enough to do.

The period of 21 years is given as the term for public lighting allowed to the contractor, after which time he may be granted further licence, or the Commission may exercise its right to purchase. He is, however, allowed to continue the supply of electricity for private purposes, provided the contract has not been determined for other reasons, such as inefficiency, &c.

It seems to us that, although it is highly desirable that the electric light should have its chance of being generally introduced into the City, the specification of conditions for supplying the electricity are so vague that great confusion will inevitably result The City authorities should have taken the necessary steps to get out a working specification which should distinctly lay down a system or systems upon which the supply would be ensured. Contractors then would have had something definite upon which to base their estimates; now it will be difficult to compare either schemes or estimates. On the other hand, it may be that the City is an ex-

ceptional place, and one in which it would be difficult to lay down a hard-and-fast rule. We can only patiently await the result.

IT is announced that Mr. Charles G. Burke, a New York electrician, has completed a cable system whereby he has been enabled to work Morse over the Atlantic cables. An American contemporary, who makes the statement, adds, "of course the substitution of the Morse sounder for the mirror and recorder means increased speed." We confess we do not see where the "of course" comes in, as we were not aware that if a sounder is applied to a long cable it means that it can work at a speed exceeding that of the mirror or siphon recorder. The statement that the Atlantic cables can be worked by Morse has been made more than once, but we never hear that this stage has been got beyond. Our American friend evidently bases his judgment upon overhead wire experiences.

"ONCE more we repeat that the idea of street illumination by means of incandescent lamps is a fallacious and mistaken one." Our estimable contemporary, the New York *Electrical Engineer*, has taken this quotation from our columns as a peg upon which to hang some good advice. Do not be too positive, neighbour, says our friend; "American experience, as we have been told over and over again, is no criterion for England." "Nevertheless, it is a fact that year by year the use of the incandescent lamp for street illumination has gained in popular estimation, and at least three of our leading companies are engaged in erecting street plants with highly satisfactory results; it looks to us as if the idea of incandescent street illumination, instead of being a 'mistaken one,' is fast becoming recognised as a very sound and satisfactory one." Were we resident in America we should probably speak out in very much the same manner as the *Electrical Engineer*; but being in London, with gas as low as 2s. 6d. per 1,000 cubic feet, and at a similarly low figure all over the country as compared with the prices which obtain in the United States, we still venture to retain our opinion, that they have no advantage over gas, and that where tried they have invariably been found wanting.

THE New York *Electrical Engineer* thus sums up the secondary battery litigation in the States:—"The decision of Judge Coxe is of the more significance, because it is apparent that he has very carefully and thoroughly considered the most important of the vast mass of prior patents and publications and uses, relied upon by the Julien Electric Company as anticipating the broad invention, and reaches the conclusion that the invention is not disclosed in any of them, and hence that Brush must be regarded as the first inventor of a secondary battery in which the active coating is mechanically applied to the electrode." Judge Coxe's decision was given very fully in our last issue.

AT the last meeting of the Institution of Electrical Engineers, Mr. John B. Verity read a paper on "Underground Conduits and Electrical Conductors." It could scarcely be expected that much original matter would be found in Mr. Verity's compilation, and the only good to which such a paper could possibly lead was the discussion which afterwards took place. This was really the object which Mr. Verity had in view, but surely this could have been achieved without inflicting upon his listeners a wearisome description of a number of conduits which were mainly familiar to readers of electrical literature. In dealing with lead-covered cables, the lecturer went very much over the ground which has already been covered by the REVIEW, and on the whole, Mr. Verity bears out the remarks which we have from time to time made.

WHEN speaking of the manufacture and quality of underground conductors, Mr. Verity very justly gives the palm to this country; but one would be inclined to think that he had been retained to write his paper in the interests of a well known company, whose goods are too well known to need any indirect recommendation.

ALL cables for high tension currents, says Mr. Verity, should be well tested before leaving the factory; "in other branches of engineering the engineer would not think of receiving his steam or hydraulic pipes without first seeing them tested to, say, over twice their working pressure." Mr. Verity had evidently written this before reading the report of the disaster at Deptford, for, so far as the evidence is concerned, which we publish in our "Notes" columns, this precaution does not seem to have been carried out.

WE shall publish an abstract only of Mr. Verity's paper in our next issue, for much of the matter therein contained has been more fully dealt with in our pages at various times. American experience, which the author largely quotes, has always received due prominence in the REVIEW, for we believe that much solid and valuable information can be obtained by a careful perusal of transatlantic successes and failures. The schemes which have had a successful termination might well be followed on this side, and the failures carry their own lesson.

Apropos of Mr. Verity's paper, the following extract from *Texas Siftings* will be read with amusement:—

"Regular meeting of the Board of Electrical Control, Mayor Grant in the chair.

"Mayor Grant (to an officer of the electric light company, who is summoned before the Board)—Has your company yet complied with the law requiring them to put their wires in the conduits?

"Electric Light Man (innocently)—What conduits?

"Mayor—The conduits laid underground to receive them.

"E. L. Man (surprised tone)—Have they been laying conduits?

"Mayor (sternly)—You know they have.

"E. L. Man (suddenly recollecting)—Oh, yes, seems to me I did hear something about it last summer.

"Mayor—Your company has promised repeatedly to bury the wires.

"E. L. Man (with a puzzled look)—Bury what wires?

"Mayor (impatiently) — Your electric wires, of course.

"E. L. Man—Bury them before they are dead?

"Mayor (with rising indignation)—We'll have no more trifling in this matter.

"E. L. Man—I never trifle with an electric wire, especially when it is alive, your Honour.

"Mayor (consulting his notes)—Over a year ago you were given sixty days to put your wires underground. Why didn't you do it?

"E. L. Man (after reflecting)—I think it rained.

"Mayor—Then your time was extended sixty days more. Why wasn't it done then?

"E. L. Man—Why wasn't what done?

"Mayor (emphasizing each word by a tap of his

pencil on the table)—Why—didn't—you—put—the—wires—under—ground ?

"E. L. Man—Oh, why didn't we ? Well, we didn't know that they wanted to be put underground.

"Mayor (getting mad)—We'll have no more fooling ; the poles must come down.

"E. L. Man—What poles ?

"Mayor—Don't your company have poles ?

"E. L. Man—Oh, yes. Now and then one, more for ornament than anything else.

"Mayor (getting ugly)—Well, if those poles are not down and the wires underground in thirty days I will know the reason why.

"The Electric Light Man bows and saunters off, satisfied that there is no occasion to hurry about it."

THE great advantages one method of conversion of energy possesses over another when favoured by circumstances is illustrated in a striking manner at the power station of the People's Electric Railway of Scranton, Penn. At a short distance from this station, says *Science*, is an almost inexhaustible supply of "culm"—the screenings of anthracite coal, which until recently was considered practically valueless. This culm, which costs little more than the expense of carting it to the station, is the fuel used in generating steam for the engine which drives the dynamos, the boiler furnaces being specially adapted to the economical consumption of such fuel. As a consequence of this cheapness of fuel, it is claimed by the officers of the road, it costs less to supply the electric motive power necessary to operate the railway than it would to furnish one horse with food and attendance. When it is known that there are 20 cars in operation on this line, and that the grades are not few in number, some of them being steep, the enormous advantages given to the electric system by such exceptional favouring circumstances are apparent at a glance. The results of two months' experience on the Scranton road makes prominent not only the fact that the electric railway is a good thing in its way, but also the further fact that many things now looked upon as useless will eventually prove to be of great economic value. The culm at Scranton is now a marketable product of the mines. The extraordinary economy in working expenses, if nothing else, makes this a notable electric railway.

DR. WERNER VON SIEMENS has been giving vent to some strong language respecting the unfortunate allusions of Prof. George Forbes to certain central electric lighting stations in Europe. This is touched upon at some length in our present issue, and we feel quite sure that Mr. Forbes will be only too ready to do anything in his power to dissipate the very unpleasant misunderstanding which seems now to exist between the Berlin and London electrical fraternities.

THE American journal *Science*, in commenting upon the Northfleet Electrical Tramway, says :—"It should be remembered, however, that in this country the system has not been uniformly successful. At Denver a great deal of trouble was experienced, to the detriment of electric traction in that section of the country, and the system is not being rapidly introduced. The large number of contacts required, the possibility of some of them failing, the great danger of burning out the motors, with other possible objections, tend to make an unfavourable comparison with systems of greater simplicity." *Science* probably does not know that the bad features of the Denver line do not exist at Northfleet.

WITH reference to lead-covered cables, the statement has been again and again made that corrosion of the outside covering could be prevented by giving the lead a coat of tar ; it seems to be forgotten that though a very thin coating of gutta-percha will insulate a wire perfectly, no one in his senses would think of trusting to such a covering, as the least scratch would render it useless ; in the same way, a very slight abrasion of the tar coating on the lead, as would be certain to occur when the cable is handled, would leave the lead unprotected, so that corrosion could set in with the usual results.

THE following details of an electric current meter competition have been published by the Prefect of the Seine :—

Resolved : Article 1.—A competition is open to all inventors of electric energy meters, for application either to continuous currents or to periodic currents, under whatever form the energy may present itself.

Article 2.—A sum of 20,000 francs will be distributed in prizes under the following conditions : 10,000 francs to the inventor who shall produce a meter giving every satisfaction ; five prizes of 2,000 francs to the inventors whose meters shall be considered the most important in the way of progress after the winner's. In case the meter shall only be applicable to one form of current the inventor shall only be entitled to one-half the prize.

Article 3.—The City of Paris will reserve to itself the right of manufacturing for the use of its municipal electricity network the prize-winning meters without paying any dues.

Article 4.—Particulars are at the disposal of those interested at the Hotel de Ville, Public Ways Office.

Article 5.—The meters must be placed under a sealed envelope, with notice from the 15th to the 25th May, at the Hôtel de Ville, at the office of the Sub-Director of Works.

Article 6.—The general secretary of the Prefecture and the Inspector-General of Bridges and Roads, Director of the Works of Paris, are charged, each of them as far as he is concerned, to assume the execution of the present resolution.

Programme.

Article 2.—The competitors may infer that a variation may be brought about either by the difference of potential alone, the intensity alone, or by these two factors simultaneously, and consequently present ampère-hour, volt-hour, or watt-hour meters.

Article 3.—The meters must especially be suitable for small consumers ; they must be capable of measuring from 20 watt-hours.

Article 4.—For alternating currents the same conditions are required, but particular attention in the construction must be paid to watt-hour meters.

Article 6.—The meters presented will be submitted to the judgment of a committee composed of nine members, five of whom are to be appointed by the Municipal Council and four by the Administration. The Committee will meet in the month of June.

Article 7.—The apparatus will be submitted to comparative experiment, which will bear on :—1, On the the proportion and exactitude of the apparatus throughout the scale ; 2, On the energy expended in effecting the measures ; 3, On the disturbance occasioned in the distribution by the employment of the meter ; 4, on the practical value of the apparatus (simplicity, regulation, net price, &c.)

THE EFFICIENCY OF METHODS OF ARTIFICIAL ILLUMINATION.*

By EDWARD L. NICHOLS, Prof. of Physics in Cornell University.

(*Continued from page* 417.)

The entire energy developed by the chemical reactions occurring in these flames per candle-power of light produced were, however, about 1,400 calories in the case of candle and oil lamps, and 4,100 calories in the case of gas, so that the gross efficiency would be respectively 0·3 per cent. and 0·1 per cent. The average ratio of total radiation reaching the thermopile to luminous radiation is about ·2 per cent., but this ratio cannot be considered in the same light as that obtained in the case of the incandescent lamp, since a gas or oil flame is in reality a column of heated vapour containing particles of unconsumed carbon, which reaches far above the luminous region, sending out dark rays from its upper and cooler portions, which do not reach the face of the thermopile at all. The relation which the total radiation of this heated column bears to the heat dissipated by convection cannot be determined, and the determination of total radiation from the light-giving portions alone is of little value. It is only in the matter of gross efficiency, therefore, that we can institute a comparison between electric lamps and the older methods of illumination, and the gross efficiency of the former depends upon the efficiency of production of electric current. Under conditions such that 10 per cent. of the total energy of the fuel consumed is converted into electricity—conditions which are, I believe, rarely attained by our present methods—the gross efficiency of an incandescent lamp, of which the net efficiency, determined by the methods which I have already described, is 5 per cent., would be 0·5 per cent., a value which is five times greater than that of a lamp burning the kind of gas used by Thomsen, and which stands in the ratio of 5 : 3 (or, probably, rather more than that) to the gross efficiency of an oil flame. These flames must, of necessity, vary very widely with the quality of the fuel consumed, and with the condition under which combustion is maintained.

If we apply a similar method of computation to the values given by Mr. Preece in his recent address at the Bath meeting of the British Association for the Advancement of Science,† assuming that the conditions under which each illuminant is consumed are such that the temperature of the incandescent carbon equals that which is maintained in the filament of an incandescent lamp at 5 watts per candle, with a net efficiency, as before, of 5 per cent., a set of conditions which can be attained in practice only in the most perfectly constructed oil and gas lamps, and which are fulfilled in many of the best of our incandescent lamps of to-day, we obtain the following results :—

TABLE VI.

Gross efficiency of various illuminants deduced from the values given by Preece. The heat equivalent of a candle is assumed to be 3·6 gramme calories per minute.

Illuminant.	Watts per candle. (Preece.)	Gramme calories per minute per candle.	Luminous radiation. Total radiation = gross efficiency.
Tallow	124	1770·	·00203
Wax	94	1340·	·00268
Sperm	86	1230·	·00293
Mineral oil	80	1143·	·00315
Vegetable oil ...	57	815·	·00442
Coal gas.....	68	971·	·00317
Cannel gas	48	685·	·00521

In considering these values it should be borne in mind that coal gas is a fuel which has been obtained by the previous expenditure of considerable energy. Were we to take as our basis the consumption of coal necessary to the production of a candle-power of light, instead of the heat of the combustion within the gas flame itself, the values for the efficiency of coal gas as an illuminant would be very considerably reduced.

We have already seen that there are excellent experimental grounds for the statement that the gross efficiency of the incandescent lamp is about ·005, and that of the arc lamp about ·01, under the assumption of the waste of 90 per cent. of the total energy of the fuel in the various processes leading to the production of the current, and that the latter figures, small as they are, are considerably in excess of the gross efficiency of candles, oil, or gas. We are in possession, moreover, of the means of expressing exactly the degree of superiority which the electric light possesses over those illuminants in the important matter of the heating effect upon the surrounding atmosphere. Gas and oil flames deliver in the neighbourhood of 1,000 gramme calories of heat per minute to the room for each candle-power, of 3·6 gramme calories of luminous radiation. An incandescent lamp of 5 per cent. net efficiency delivers only 72 gramme calories per candle-power.

The net efficiency of the incandescent lamp may be raised somewhat by increasing the temperature of the carbon filament, and, indeed, it has already been somewhat raised by the introduction of the new "3-watt" lamps. These lamps have been excluded from this discussion because we have as yet no complete data with reference to them, and because it seemed desirable, aside from that, to institute comparisons between sources of illumination in which the degree of incandescence was the same, and for all of which, consequently, candle-power had the same meaning.

When we raise the temperature of our source of light, however, we introduce changes, of which the methods thus far considered take no cognizance.

In increasing the degree of incandescence, the ratio of luminous energy to total energy of radiation is slowly increased, and at the same time the relative brightness of the various rays which constitute the visible spectrum changes. In a word, the *quality* of the light changes, and we are confronted by important variations which cannot be expressed in candle-power.

The investigation of these changes in composition, upon which colour depends, involves the study of the visible spectrum of the source of light and the comparison of its intensity, wave length for wave length, with the spectrum of some properly chosen standard. The instrument necessary to this work is the spectro-photometer, by means of which the spectra of the two lights to be compared are brought together in the field of view, one above another, like wave lengths everywhere in the same vertical line. The measurements consist in bringing the two spectra to the same intensity in each of the regions selected for observation successively, and in determining the amount by which it is necessary in each case to reduce the intensity of the brighter. A variety of devices have been made use of for varying the brightness of the spectra, and the standards of comparison adopted by different observers have included the candle, the petroleum flame, the gas flame, and the incandescent lamp, maintained at a constant voltage. Thus W. H. Pickering* obtained the necessary range of intensities by placing the lamp under inspection upon a sliding carriage and varying its distance from the slit of the spectroscope. His standard of comparison was a gas flame. H. C. Vogel† used as his standard a petroleum flame. Crova,‡ who brought the intensities of the two spectra to equality by means of a polarising device, adopted the moderator lamp as a standard. Otto Schumann, in his study of the incandescent lamp, made use of a "benzine" candle. The in-

* A paper read before the American Institute of Electrical Engineers, March 12th, 1889.

† Preece: Address before Section A, meeting of the B.A. at Bath, 1888. *Nature*, Vol. XXXVIII., p. 496.

* W. H. Pickering, *Proceedings of the American Academy of Arts and Sciences*, Vol. XV., 1880.

† H. C. Vogel, *Berliner Monatsberichte*, 1880, p. 801.

‡ A. Crova, *Comptes Rendus*, 87, 1878, p. 322.

tervention of a revolving disc with open and closed sectors and of wedges of smoked glass have also been applied to the regulation of the intensity, and the method of varying the width of the slit itself, a device due to Vierordt, has been found to give good results, where the range of intensities was inconsiderable.

The methods of presenting the results of this class of measurement have differed as widely as the methods of observation and the choice of standards; but it is possible wherever the data are properly given and the character of the standard is known, to reduce them all to a common basis of comparison. When thus reduced these measurements are found to agree in all essential particulars, and they afford us very definite knowledge of the character of the light emitted by the sources of illumination to whlch the spectro-photometer has been applied.

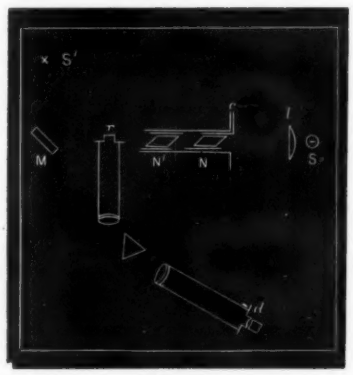


FIG. 7.

Fig. 7 shows the form of the spectro-photometer recently used by Mr. W. S. Franklin and myself in an extended series of observations upon artificial sources of illumination, and in the comparison of their spectra with that of daylight.

To the slit of a one prism spectroscope are attached a set of total reflection prisms, r, by means of which rays may be introduced into the upper and lower halves of the slit, these rays coming respectively from sources of illumination placed to the right and left hand in a line at right angles to the axis of the collimator tube. The standard of illumination, which is an incandescent lamp, S, maintained at 16 candles, is placed at the observer's right hand.

Its rays having been rendered parallel by means of a condensing lens, l, pass through a pair of Nicol's prisms, N and N′, the first of which is free to revolve, and enters the upper half of the slit. The intensity of the spectrum of this lamp can be reduced at will by the rotation of the first Nicol, and its brightness is calculated from the angle between the planes of polarisation of the two Nicols. To the left of the slit is mounted a block of magnesium carbonate, its face vertical and forming an angle of 45 degrees with the axis of collimation of the spectroscope. The rays of the source of light to be investigated, S′, which is placed at a convenient distance, fall upon the magnesium carbonate, and it is such of the diffusely reflected rays from the latter as reach the total reflection prisms, and thus enter the lower half of the slit, which form the second spectrum. The object gained by the interposition of this white surface is an important one. All artificial light, except that from an incandescent lamp, emanate from glowing materials varying greatly in temperature, and the spectrum obtained directly from the source is always that due to some particular portion of the luminous body under investigation, to the exclusion of the remainder, and differs more or less in character from that of the source taken as a whole.

The spectrum of rays reflected from the face of the magnesium carbonate, however, contains in proper proportions the light from all portions of the source, and one of the chief sources of error to which spectrophotometric work is subject, is thus eliminated.

The investigations made with this instrument, which have been described in a paper read before the American Association,* included the measurement of candle flames, and of various petroleum and gas lamps, also of the limelight, the incandescent lamp under a wide range of conditions, of the electric arc and of daylight by clear and by clouded sky. The results obtained illustrate the precise character of those differences in composition to the bearing of which, upon the study of the efficiency of artificial illumination, I desire to call your attention.

In the first place it was found that the light of the candle, and of oil and gas flames, although subject to considerable fluctuations from variations of the condition under which combustion occurs, differ but slightly in quality from each other and from that of incandescent lamps maintained at normal candle-power. The incandescent material in all is carbon, and it is a significant fact that the average temperature of incandescence is nearly the same in all luminous flames, and that the highest temperature, until very recently at any rate, at which it has been found practicable to maintain the carbon filament of the glow lamp, is very nearly that at which the same material exists under the most favourable conditions in oil and gas flames. Hence it is that the radiant energy per candle-power, as has been shown by Julius Thomsen, is nearly the same for all these flames.

Passing to other sources of illumination, such as the lime light and the electric arc, we find the entire portion of the spectrum lying beyond the yellow increasing more rapidly, regions of longer wave length than the yellow increasing less rapidly than the candle power; the rate of increase growing steadily as the wave length diminishes from the red to the violet end of the spectrum. Fig. 8 shows the results of comparisons of the spectra of the lime light, electric arc, and of daylight,

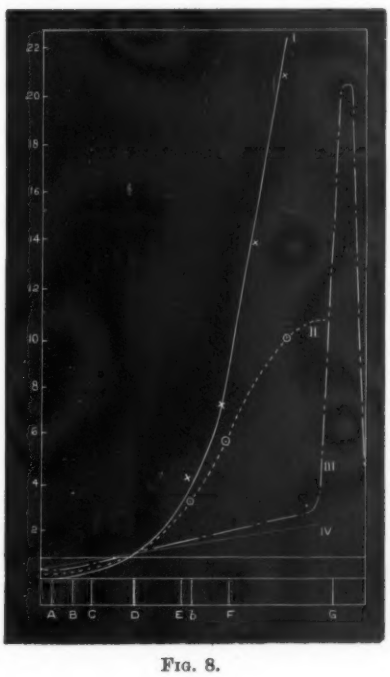


FIG. 8.

by clear and by unclouded sky, with that of an incandescent lamp maintained at its normal candle-power. This lamp, which was chosen as a standard of comparison, was an Edison 16 candle, 100 volt lamp. Its light was precisely similar to that of a "Board of Trade" argand gas burner, showing the same relative brilliancy throughout the whole of the visible spectrum. The

* Edward L. Nichols and W. S. Franklin. "A Spectrophotometric Comparison of Artificial Sources of Illumination." Paper read before Section B.; A. A. A. S. at the Cleveland meeting, August, 1888.

measurements were made with the spectrophotometer just described (see fig. 7), the light in every case falling upon the block of magnesium carbonate, and entering the slit of the spectroscope after reflection from the face of the latter. For purpose of comparison, the brightness of the standard incandescent lamp has been taken as unity throughout the spectrum. If we make a diagram in which abscissæ are wave lengths, and ordinates, intensities, referred to that of the standard as unity, the curve for this lamp will be a straight horizontal line, with ordinate = 1.

All other spectra are reduced to the same brightness in the region of the D line of Fraunhofer, and their brightness in other regions, referred to that of the corresponding wave length in the spectrum of the standard, is shown by means of curves.

Observations were made in ten regions of the spectrum, equidistant as to wave length, and embracing the whole of the visible spectrum. It will be seen by reference to the fig. 8 that the lime light, curve IV., is relatively much stronger in the violet and much weaker in the red than the standard. In the arc light, curve III., this increase of intensity toward the violet is even more marked, but its variation in quality from the lime light is by no means so great, as its exceedingly brilliant, bluish-white appearance to the eye would lead us to expect. The source of that appearance, and of the very high actinic value of the arc is found, however, in the presence of an exceedingly bright band in the extreme violet. Here the relative intensity of the arc light spectrum rises abruptly about three to 20 times that of the incandescent lamp.

Measurements were made upon a long arc lamp with ½-inch carbons, with 10 ampères and 50 volts and a short arc lamp with a 20 ampère current. The character of the light was found to be almost identical excepting in this light band in the neigbourhood of the G line, which is much more prominent in the long arc lamp. The character of the light was found to be much the same at all angles below the horizontal plane.

The only other spectrophotometric measurements of the electric arc with which I am acquainted, have been made upon the Foucault regulator, a lamp with carbons of small diameter. Fairly concordant determinations of the distribution of intensities in the spectrum of this lamp by W. H. Pickering,* H. C. Vogel,† and Crova,‡ show that the light of this lamp is decidedly bluer than that of the lamps with large carbons in vogue at the present day; the spectrum of the former being about five times as rich in the violet as that of gas or oil flames. Mr. Nakano's results, of which mention has already been made, indicate marked increase in the efficiency of the arc lamp, as the diameter of the carbons is decreased; and since increase of efficiency arises from a higher average degree of incandescence, we should expect just such an increment in the shorter wave lengths as shows itself in the case of the Foucault regulator.

Finally, in the case of daylight we find the intensity of the shorter wave lengths exceedingly great as compared with that of any artificial source of illumination. If the spectrum of daylight be brought into comparison with that of an incandescent lamp, and the two be reduced to the same intensity in the yellow, the extreme red of the daylight spectrum will be so *dim* in comparison with that of the lamp as to render measurements difficult. In the violet the discrepancy will be just as marked, the sun's spectrum being relatively of enormous brilliancy. Curve I., fig. 8, shows the result of such a measurement of the daylight spectrum, taken just after noon upon a cloudless summer day.

Vogel has given data of a determination in which the preponderance in the violet was even more marked, the relative intensity of daylight for the region corresponding to wave length, 4,260 (just beyond the G line), being 100 : 1 for spectra which were equally bright in the neighbourhood of the D line.

Ordinarily, there is considerable absorption of the blue and violet by moisture in the atmosphere, and a measurement of daylight under a densely clouded sky gave Curve II. Even under these conditions, with the violet reduced to about one-tenth of the value which it possesses in clear weather, daylight is very much bluer than any artificial light. The light emitted by burning magnesium approaches more nearly to it than any other, being, according to Pickering, considerably stronger throughout the blue and violet than the light from the Foucault arc lamp. Its colour, however, is not reinforced by a violet band like that in the spectrum of the electric arc, a region which by its extraordinary brightness has marked influence upon the colour of the light.

These variations depend upon temperature primarily, and they may be studied to the best advantage in the spectrum of the incandescent lamp. The radiating surface of such a lamp is at a nearly constant temperature throughout, and it may be given a very considerable range in the matter of incandescence, involving variations in colour and total intensity, which are under complete control.

An Edison lamp, similar to that which had been used as a standard in our previous measurements, was subjected to spectro-photometric analysis by Mr. Franklin and myself, at 4 candles, 10 candles, 16 candles, 22 candles and 28 candles, successively. The results obtained are shown in fig. 9.

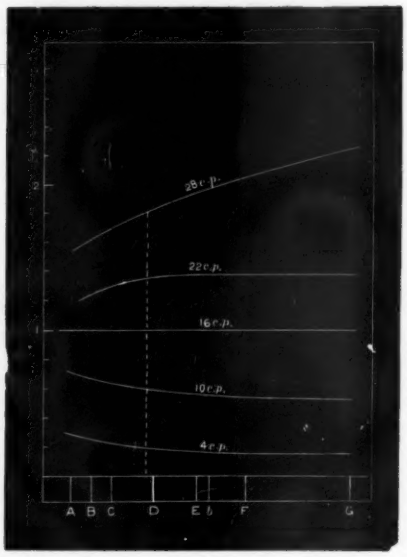


FIG. 9.

The spectrum of the lamp at 16 candles is taken as of unit brightness throughout, and the other curves show the amount of light of each wave length emitted by the lamp in the above-mentioned states of incandescence. Intensities, in every case, are referred to the light of corresponding wave length, given by the same lamp at 16 candles, as unity.

At the red end of the spectrum the intensity increases more slowly than candle-power, at the violet end more rapidly. There exists an intermediate wave length, for which the brightness is proportional to the candle-power. The vertical line in the diagram shows the portion of the spectrum for which this holds true, a point in the yellow at wave length 6,000.

If we suppose the same measurements executed upon a set of lamps in every respect similar to the one in question, excepting that their radiating surfaces are of such size that they give 16 candles, as indicated by the Bunsen photometer when the degree of incandescence corresponds respectively to that at which the lamp actually measured emitted at 4, 10, 16, 22 and 28 candles, there would result a set of curves of the same general character as those in fig. 12. At wave length 6,000, these curves would have a common value, and they

* W. H. Pickering, *l. c.* † H. C. Vogel, *l. c.* ‡ A. Crova, *l. c.*

would serve to indicate both the quantity and quality of the variation of the carbon filament, as a function of the incandescence, candle-power remaining constant. The form of these curves is shown in fig. 10. They afford us data for discussion of the candle as a

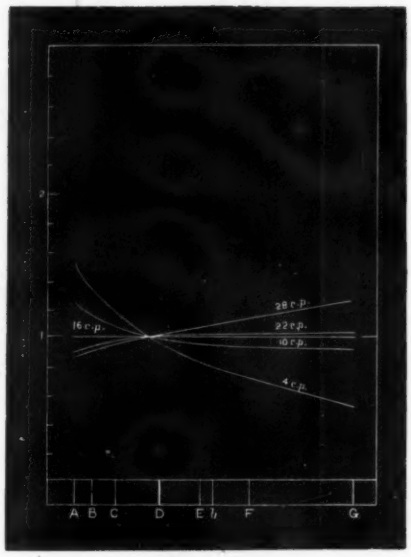


FIG. 10.

standard of illumination which could not be obtained in any other way. They show the relative distribution of energy in the spectrum of five lamps, which, according to the indications of the Bunsen photometer, are of equal brightness, but which differ both in the quality and in the total energy of their luminous radiation. Their efficiency expressed in terms of the candle-power produced per watt expressed in the lamp, rises rapidly as the incandescence increases. For lamps of the type upon which these measurements were made for instance, the relative efficiency referred in each case to that of the lamp, the incandescence of which corresponds to that of an Edison lamp at 16 candles, is given in the column headed $\frac{\text{candle-power}}{\text{watts}}$ in Table VII.

TABLE VII.

State of incandescence equivalent to that of an Edison 16-candle lamp giving—	Relative efficiency referred to that of a 16-candle lamp as unity.	
	Candle-power. / Watts.	Luminous radiation. / Tota lradiation.
(1) 4 candles	·394	·211
(2) 10 „	·729	·632
(3) 16 „	1·000	1·000
(4) 22 „	1·218	1·368
(5) 28 „	1·391	1·589

If, however, we retain as the measure of efficiency, the ratio, $\frac{\text{luminous radiation}}{\text{total radiation}}$, we can deduce from these curves value coinciding with those reached by the method of the thermopile and alum cell. To this end we must know the above-mentioned ratio for some 1 candle-power and the number of watts necessary to the production of each state of incandescence for which the computation is to be made.

The relative efficiency can then be calculated from the areas inclosed by the respective curves. Were the candle-power proportional to the energy of luminous radiation, the values thus obtained would be identical with the relative efficiency determined from the relation of candle-power to watts. The relative efficiency thus computed (see Table VII.) does not coincide with that obtained from the ratio of watts to candle-power, however, for the reason that the various rays which make up the visible spectrum do not enter into the production of candle-power in proportion to their energy. The most important wave lengths, so far as light-giving power is concerned, are those which form the yellow of the spectrum, and the relative luminosity falls off rapidly both toward the red and the violet. The longer wave lengths have, however, much more influence upon candle-power than the more refrangible rays, as will be seen by an inspection of the curves, the relative falling off of the red end of the spectrum being compensated by larger and larger accessions in the blue and violet as the state of incandescence increases.

Luminosity is the factor which we must take into account in seeking a complete expression for the efficiency of any source of illumination, and the method to be pursued in the determination of the luminosity must depend upon the use to which the light is to be applied. If we estimate light by its power of bringing out the colours of natural objects, the value which we place upon the blue and violet rays must be very different from that which would be ascribed to them if we consider merely its power of illumination as applied to black and white. In a picture gallery, for instance, or upon the stage, the value of an illuminant increases with the temperature of the incandescent material, out of all proportion to the candle-power, whereas candle-power affords an excellent measure of the light to be used in a reading room.

A number of determinations of the luminosity of artificial light have been made. In the earliest of these by Vierordt,* the amount of white light which may be mixed with each colour of the spectrum, without producing an appreciable change of tint, was taken as the measure of the luminosity of that colour. The result is shown graphically in fig. 11. The curve indicates

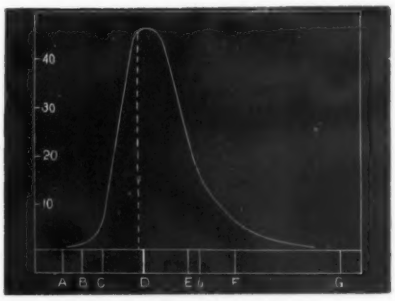


FIG. 11.

the light-giving power of each wave length, estimated in the above manner. The source of light experimented upon was a petroleum flame. The vertical line indicates the region of the spectrum within which—according to the measurements of the quality of light of the incandescent lamp already described—the increase in the brightness of the spectrum is proportional to the candle-power. This region corresponds very nearly with that of maximum luminosity of the spectrum.

The luminosity of the blue and violet rays is so very small that in the production of *candle-power* the influence of the very rapid growth of this end of the spectrum with increasing temperature of the lamp is scarcely appreciable. If we estimate the light-giving value of the different portions of the spectrum by means of the facility with which we can distinguish black characters upon a white ground, the importance of the more refrangible rays is still farther diminished. Thus Macé de Lepinay and Nicati † have shown that if yellow and blue light, estimated to be of equal brightness by photometric means, are of such intensity that one can clearly distinguish a printed page when illuminated by the yellow, the same page will be entirely illegible

* C. Vierordt, *Annalen der Physik und Chemie*, Bd. 137, p. 200.

† Macé de Lepinay and W. Nicati, *Journal de Physique*, second line, T. 2, p. 75, 1883.

when the blue light alone falls upon it. These observers conclude, indeed, that "the mere distinguishing of is due objects almost exclusively to the illumination produced by the less refrangible half of the normal spectrum;" so that at equal brilliancy "the superiority of yellow sources of light (luminous gas flames, incandescent lamps) over sources richer in blue rays (light of the electric arc) is incontestable." "The only real advantage," they add, "upon the side of the light from the electric arc is when one desires to rehabilitate objects more nearly in the hues which they present in the light of day." The single advantage is one which it is impossible to take due account of, numerically, in an estimate of the efficiency of artificial illumination. It is nevertheless a most important factor in determining the adaptability of a light to nearly all the purposes of every-day life.

Otto Schumann,* to whom we owe a most exhaustive study of the light of the incandescent lamp, has determined the luminosity of several types of such lamps at various stages of incandescence. His results, in so far as they apply to a 16-candle Edison lamp, are given in Table VIII.

TABLE VIII.

Luminosity of an Edison lamp at various stages of incandescence, according to Otto Schumann.

Amps.	Volts.	Watts.	Luminosity of various regions of the spectrum.						
			Red λ = 676.	Orange λ 636.	Yellow λ 615.	Green λ 557.	Blue λ 487.	Indigo λ 464.	Violet λ 429.
0·625	87·3	54·6	1·18	4·64	....	20·14	0·64	0·11	....
·678	90·4	61·3	1·58	6·06	....	30·35	1·05	0·20	....
·727	94·7	68·8	2·24	9·34	53·11	50·05	1·71	0·34	....
·748	97·4	72·9	2·59	10·92	63·28	62·23	2·28	0·47	....
·823	105·0	86·4	4·06	17·14	99·22	104·3	4·09	0·88	....
·944	112·9	106·7	6·97	28·85	163·0	189·1	7·88	1·75	....
1·009	117·6	118·6	8·74	37·14	222·6	253·7	11·62	2·71	0·42
1·035	120·4	124·7	9·36	41·67	263·3	317·7	16·04	3·79	0·60
1·099	124·5	136·4	11·43	52·96	345·2	472·2	26·24	6·53	1·04

I have made these values of Schumann's the basis of a set of curves, by means of which the variation in luminosity, with total energy in watts, is exhibited (see fig. 12). It will be seen that the position of the maximum moves slightly towards the violet as the brightness of the lamp increases. This tendency is very slight within the range of temperatures reached by the incandescent lamp. In the arc light we should find the displacement most marked, but in the case of sunlight, in which, as we have seen, the shorter wave lengths are in such preponderance, the movement of the maximum is inconsiderable. The curves shown in fig. 13 are taken from the investigation by Crova, who has determined the distribution of luminosities in the spectrum of sunlight and of the flame of a petroleum lamp. The maximum in sunlight is at $\lambda = 582$, that of the petroleum $\lambda = 592$. Nearly all sources of illumination will be found to have a maximum lying between these two wave lengths.

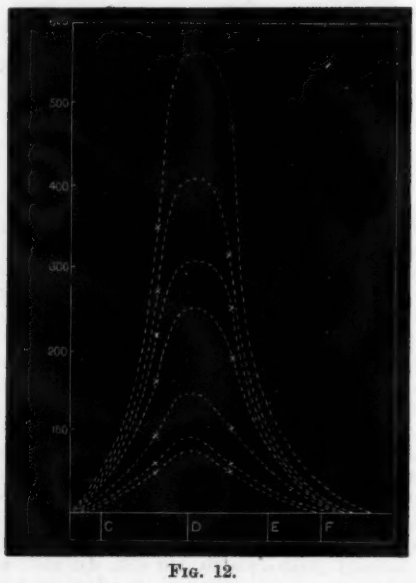


FIG. 12.

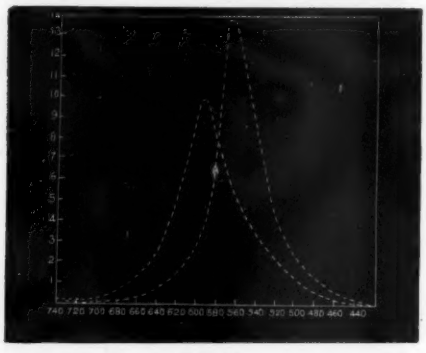


FIG. 13.

A comparison of the total luminosity of the incandescandescent lamp with its candle-power shows that the former increases with the energy of the lamp more rapidly than the latter, although the discrepancy is not so marked as in the comparison of efficiency of candle-power with that of luminous radiation. The following table, obtained by the summation of the luminosity curves, shows the relation between candle-power and total luminosity, in the case of the lamp studied by Schumann :—

TABLE IX.

Candle-power and total luminosity of the incandescent lamp.

Watts.		Candle-power.		Total luminosity.
54·6	...	...	...	4·11
61·3	...	...	...	6·31
68·8	...	10·12	...	10·20
72·9	...	12·05	...	12·58
86·4	...	18·80	...	20·64
106·7	...	31·60	...	36·80
118·6	...	41·44	...	49·77
124·7	...	50·16	...	60·85
136·4	...	64·15	...	...

Plainly, then, candle-power does not afford a measure either of the light-giving energy or of the luminosity of a source of illumination. When used in the comparison of sources which differ in temperature, the indications of the photometer always yield us relatively too low a value for the intensity of the lamp of higher incandescence. In the case of candles *versus* gas, or of either of these in comparison with the incandescent lamp at normal temperature, the error is not important, but between the candle and the "16-candle" lamp maintained at 50 candle-power, the discrepancy amounts to 10 per cent. For the electric arc the ratio of candle-power to total luminosity is very nearly 4 : 5, and in the case of daylight it is about 4 : 6.

In arc light photometry, candle-power is already a well-nigh meaningless term. Would it not be well to abandon it altogether in favour of some standard affording us an expression for the luminosity of radiation? So far as the incandescent lamp is concerned, light-giving power is a perfectly definite function of the temperature and of the area of the radiating surface. We are, unfortunately, not in position at the present day to measure the temperature of an incandescent filament, but the time will undoubtedly come when the relation between the temperature and the quality of the light emitted by glowing carbon will be definitely known. We may, indeed, look forward to the development of some optical method for the measurement of the temperature of incandescence which shall be as easily performed as our present method of

* Otto Schumann, *Elektrotechnische Zeitschrift*, Bd. 5, p. 224, 884.

determining candle-power, and which shall admit of a much higher degree of precision. The comparison of lamps, the temperatures of which are the same, will then reduce itself to a question of radiating surface. Total luminosity and total energy of luminous radiation, per unit of surface, together with net and gross efficiency, may then be expressed, in so far as incandescent carbon is our source of illumination, as functions of the temperature alone, and the performance of any lamp may be defined in terms which admit of no uncertainty.

UNDERGROUND CONDUCTORS FOR ELECTRIC INSTALLATIONS.

PROF. FORBES AND DR. WERNER VON SIEMENS.

A PAPER recently read by Prof. Forbes before the Institution of Electrical Engineers has given no small offence in Berlin, and has elicited from Dr. Werner von Siemens a warm reply. Prof. Forbes unfortunately said in his paper that he had been surprised at finding at the Berlin central station, which was arranged in a very systematic and effective manner, exclusively German work and certainly, at least, nothing American. Dr. von Siemens commenting on this passage says that "Mr. Forbes and his countrymen will have to become accustomed to the thought that the days are over when English technical skill exclusively ruled the world, and that on the other side of the sea there can now be found admirable technical constructions."

It seems to us that Dr. von Siemens is here rather astray. Prof. Forbes expressed his surprise at the absence of *American*, not of *English* mechanical ability. He thus fully admitted, what every child has become accustomed to, that Britain has now no monopoly of engineering ability. Forbes had expressed no surprise at the absence of British workmanship in the Berlin installation. Again, in the discussion which followed, Dr. von Siemens, returning to the subject said, "The English are rather accustomed to indulge in hard and sharp criticism of foreign performances, as if there were not on the other side of the Channel people capable of great things."

It seems on the contrary to many persons that we, in Britain, are too much accustomed to under value everything of native origin and to give foreigners every advantage.

But coming to more definite matters, the distinguished Berlin electrician protests against the opinion expressed by Prof. Forbes on the imperfect durability of cables laid in lead pipes armed with iron. These, on the alleged authority of Messrs. Rathenau and Datterer, he pronounced serviceable for terms of three years, but at the end of that time liable to general corrosion. Dr. Siemens urges that an electrician of such eminence ought not to have passed so condemnatory a judgment without a close and careful examination of the system. He further denies the alleged facts, maintaining that the Munich cable net constructed on this system, and which is now in the fifth year of its existence, is still in a serviceable condition. The portion of the Berlin net, 51,700 metres in length, which was laid down 3½ years ago, has so far undergone no change, as has been ascertained on digging down to the cables in about 40 places. In the portions laid down in 1886 and 1887, four defective places have occurred in consequence of accidents, but they have been rectified, and since that time, as Director Rathenau has testified, no further complaints have arisen. Two of the four faults had been caused by the blow of a pick. He cites the fact that in earth free from organic matter lead may remain undestroyed for thousands of years, as is proved by the remains of Roman waterworks. He admits the necessity of preserving the lead pipes from contact with soils containing organic matter. This cannot be effected by bedding in lime or cement which themselves have an injurious action. The lead is therefore coated first with asphalt, then with jute saturated with asphalt—asbestos being still better—finally with a double spiral of sheet iron. Dr. von Siemens admits the porosity of lead compressed into piping at a heat close upon its melting point. Such pores allow moisture to penetrate to the cable. But he has succeeding in moulding cold lead into pipes by the application of an enormous pressure, thus avoiding the porosity observed. At points where there is danger of mechanical injury, the cables should be covered with plates of iron or stone, or laid in channels of masonry filled with sand.

Towards the close of his paper Dr. von Siemens further said :—"I believe, gentlemen, that we can and must learn this one thing from the English, to defend our rights strenuously, and especially such foreign, reckless, and ungrounded attacks as the present. He hopes that the Institution of Electrical Engineers will not refuse the reproduction of his memoir in their organ.

In the discussion which ensued doubts were raised whether Prof. Forbes and Director Rathenau have rightly understood each other, and whether the former may not have gone away with a wrong impression. This view was suggested by Privy Councillor Bensen and Director O. von Miller, who seemed reluctant to impute to a man like Prof. Forbes any conscious and intentional misrepresentation. A hope was expressed that certain expressions in the beginning of the paper might be toned down, and it was recommended that before the discourse was printed the exact language used by Director Rathenau in his communication to Prof. Forbes should be ascertained. Both these conciliatory suggestions were declined by Dr. Werner von Siemens.

In reply to the former he contended that the strong language of Prof. Forbes demanded an equally strong reply, and adding that the latter had received at the Society of Electrical Engineers criticism no less incisive than what the speaker had just brought forward. If so, we may ask what is the ground for the charge insinuated of English injustice to foreign merit?

Dr. von Siemens further said that he had waited in the hope of explanations for four weeks. He had spoken according to his convictions, and must beg that his memoir might be printed exactly as delivered. Still, he admitted very distinctly the existence of a misunderstanding.

As regards the practically important point, the duration of lead cables, Director von Miller pointed out that the circumstances at Munich were extremely favourable for their duration. The lead cables, coated with sheet iron, were covered with sand and protected with layers of bricks in a subsoil of coarse gravel. Excavations are scarcely ever undertaken in the streets concerned, and no gas mains run along the cable. In Berlin, also, the sandy character of the sub-soil is especially favourable. The speaker mentioned one case where a short circuit had occurred between the lead and the copper, though the iron coating showed no marks of injury. In three cases the lead cable and its coating were melted together in such a manner that the original cause of the mischief could not be definitely ascertained. It has been suggested that an electrolytic action may have been set up between the lead and the iron in consequence of the introduction of organic acids; but the presence of organic matters in the soil, which Dr. von Siemens had declared injurious, may have destroyed the lead and the iron. In Munich the lead cables were rapidly destroyed at a corner where certain organic acids were to be met with, and that the lead cables were rapidly destroyed near gasworks and hospitals.

He suggested that the wires might be laid in a channel filled with the well-known Monier-mass, and of about 25 centimetres square. The cost of such an arrangement would be from 20 to 40 per cent. less than that of leaden pipes armed with sheet iron.

W. von Siemens doubted that an unfavourable soil could set up corrosion in asphalted cables, in the absence of some flaw or injury in the casing. If such a defect is present the results will be much more serious

in a soil saturated with chlorides than in one of pure sand.

Against the proposal to lay the wires in channels he urged that this arrangement would be difficult in towns with narrow, crooked streets, where the available space is much engaged for other purposes. In such cases it would be necessary to employ a two-fold system—cables in the narrow streets and wires in channels in the broad ones. A further disadvantage of the channels would be that in case of an inundation or the rupture of a water main they might become filled with water.

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 381.)

VI.—ARMATURES IN PRACTICE—(*continued*).

THE armature core may be flattened to resemble a disc, having consequently the greater dimension of its cross-section perpendicular to the shaft, instead of parallel to it as in the machine last described. When constructed in this way the magnets lie in a circle, with their poles arranged alternately on each side of the disc, as was shown in fig. 59 (page 698, Vol. XXIII.). In the latest form of this alternator the armature core is made by winding on a cast iron supporting ring a thin ribbon of soft wrought iron, the adjacent layers being separated one from the other by paper. The ring side frames which constitute the yokes of the magnets are of cast iron, the magnet cores being of wrought iron with pole shoes of rectangular shape tapered on the inside as shown in fig. 86. In the fig., N, S, N, are the magnets, D, a part of the armature core and A, B, C armature coils. The rectangular form of pole piece is adopted in order to obtain on the sides of the disc the

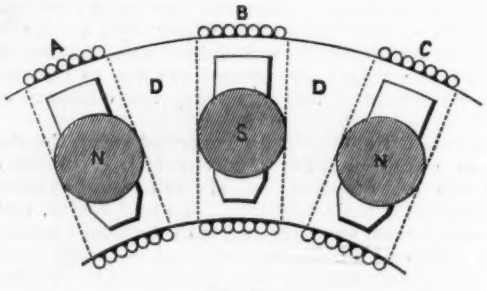


FIG. 86.

largest possible ratio between the area of the pole and the pitch of the magnets, and so reduce the waste field, while the tapering inwards is employed for the same reason. There are as many armature coils as there are opposite pairs of magnets. In this machine the magnetic circuit is divided, or for each pole there are two magnet cores instead of one, as in the last example. We may, therefore, conclude that in this type a greater amount of wire will be required on the magnets—first, because the added peripheries of the two cores have a greater length than the periphery of one double the area; secondly, because in machines with divided magnetic circuits the waste field is generally increased. The product of the magnetising current and length of wire will be greater than in the previous machine, but the actual increase will depend on the relative sizes and shapes of the cores in each.

In this machine the active parts of the conductors are on the sides of the disc, and it will be observed from fig. 86 that they cover rather more than one-half the circumference of the armature measured on the pitch line of the magnets. The coils are connected up as in the last machine (fig. 84), and the same remarks apply as regards the relative activity of different portions of the coils. The equation for the E.M.F. is the same, but N is now the number of lines entering the armature from each *pair* of poles facing on its opposite sides. To get a true value for the E.M.F., the expression must be multiplied by some coefficient, as in the former case, the value of which—always less than 1—depends on the width of the coil and the distribution of the field.

The armature of an early Zipernowsky alternator is the next to claim our attention. Here the armature ring was made of soft iron wire, as in the Gramme machine (fig. 83), the field magnets being arranged radially inside, and of alternate polarity. But the coils, instead of being wound over the exterior and through

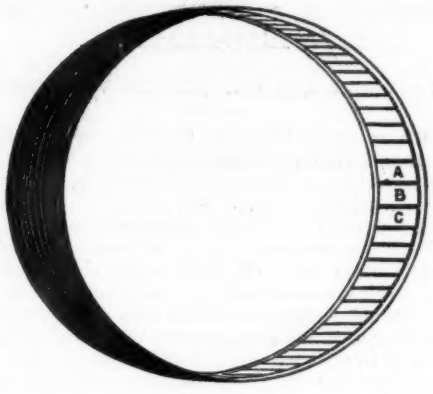


FIG. 87.

the interior of the ring so as to embrace its cross-section, were of flat rectangular form, and merely laid side by side on its interior surface, as shown at A, B, C, fig. 87. The number of coils on the ring was equal to the number of magnets, and the diagram in fig. 88 shows the way in which the coils were connected in series with each other.

Recently this machine has been improved in some of its details by English makers, who have built the arma-

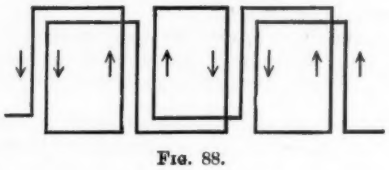


FIG. 88.

ture ring of segmental plates of thin soft iron, separated from each other by paper or other suitable material. The flat coils, A (fig. 91), are of insulated copper tape, wound upon a core of wood, B, having rounded ends. These are placed on the inner side of the ring, as in fig.

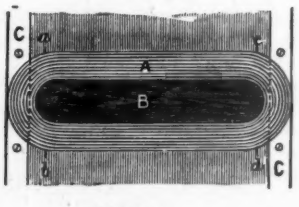


FIG. 91.

87, being kept in position by wooden strips, C (fig. 91), screwed to the outer frame of the dynamo. The distribution of the field in this machine is as shown in fig. 92, where N_1, S_1, N_2, S_2, are radial magnets, presenting alternately N and S poles to the armature ring, R, R, and *a*, *b*, is one of the coils. The width of the magnets is about half their pitch, the outside width of the coil being about equal to the pitch. The wood core, upon

which the coil is wound, has a width equal to half the pitch, or, in other words, there is an opening in the middle of the coil corresponding to the width of the magnet. When the magnets are in the position shown in fig. 92, the E.M.F. in the coil is nought, it being the position of reversal. It will be seen

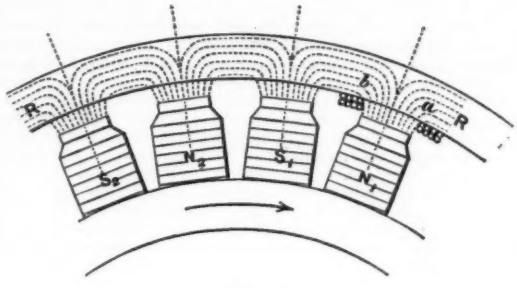


FIG. 92.

that owing to the spread of the field every convolution of the coil does not enclose all the lines of force from N_1. The E.M.F. will be, therefore, something less than that which would be given on the assumption that each convolution was equally active; that is, we have, as in the former case, to multiply N, the number of lines from each pole by a coefficient depending on the spread of the field. Assume for the moment that all the lines from N_1 pass through the coil, and that the magnets move in the direction of the arrow. While moving from the position shown to one in which S_1 is in front of the coil, evidently all the wires at *b* have cut N lines from S_1, and all the wires at *a*, N lines from N_1. At this point there will be a reversal, and on moving from here to a position where N_2 is in front of the coil a similar number of lines will be cut, the cycle being now complete. Each wire cuts, then, 2 N, or each convolution 4 N lines per cycle, and the E.M.F. in volts is :

$$E_{\text{average}} = \frac{2 N p s c}{10^8},$$

where the letters have the same signification as in previous expressions.

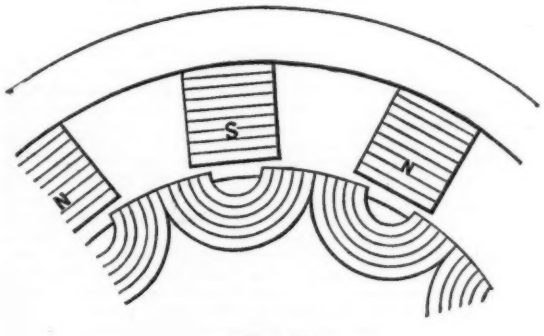


FIG. 93.

Another machine, having flat coils laid on the surface of the armature, is the Westinghouse alternator. The armature, in this case, rotates while the field magnets are arranged radially on an outside ring, as shown in fig. 93. The poles presented to the armature are of alternate polarity, and the number of armature coils corresponds to the number of poles. The armature core is built up of thin iron discs, separated by paper, there being several large holes through the interior of the core thus formed to provide for efficient internal ventilation. The coils are of flat shape with rounded ends, as in the former example, but these ends are bent downwards over the end plates of the armature core, as shown in fig. 93, and secured in that position. The width of the magnets is about ·45 of their pitch, the inside width of the coils being about ·27 of the pitch, and the outside width equal to the pitch. The openings in the coils are filled with insulated pieces, the whole being secured by circumferential binding bands. Owing to the openings in the coils of this machine being less than the width of the magnet (about ·6 of the width), the inside convolutions enclose at the position of reversal a less proportion of the lines emanating from the magnet than in the former machine, and the coefficient by which the expression given above has to be multiplied to get the E.M.F. has, therefore, a less value.

It may be instructive to institute, as far as our progress up to the present justifies it, some comparison between these different types of machine. We have considered :—

1. A ring armature having the ring enveloped by the coils and the magnets arranged radially outside.
2. A disc armature having the disc enveloped by the coils and the magnets arranged on each side.
3. A ring armature having the coils laid on its interior surface and the magnets arranged radially inside.
4. A ring or drum armature having the coils lying on its exterior surface and the magnets arranged radially outside.

Suppose we have a machine of the first kind having an armature core of given diameter and cross section and a certain number of magnets. A section through the armature and field of this machine is represented in fig. 94, A being the armature core, M one of the magnets and R the yoke ring. The cross section of R, of M, and of A are the same which would mean, if the yoke ring is of cast iron and the magnets of wrought, that the induction in the former per centimetre is half that in the latter, and that the useful induction in the armature core is also half that in the magnet. The length of the armature core is five times its thickness, which is a very usual proportion. We will call the length of the wire on each convolution on the armature, also on each convolution of the magnet = 12, being two lengths along the core of 5 and two across the ends of 1. Now, suppose we have to construct a machine of the second kind and of the same output. If the speed, diameter of armature, and number of poles are to be similar, the induction required through the armature core will be as before. There will be the same number of lines entering the armature, but

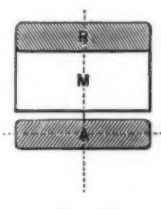


FIG. 94.

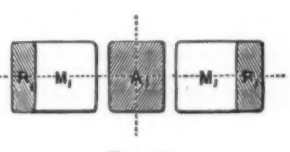


FIG. 95.

now they will enter at two sides instead of one. Let us assume that for the new machine we adopt the cross section shown in fig. 95. Here the radial depth is equal to half the length of A and the width equal to twice the thickness of A. Since the area of M_1, M_1 added are equal to M, the waste field may not be much greater than before. Obviously the length of wire in each convolution on the armature has been reduced from 12 to 9 and the length of the wire on the magnets increased from 12 to 14. We say the waste field may not be much greater, but it will certainly be increased because the magnets are closer together at their inside edges for an armature of the same mean diameter. To reduce it as much as

possible it is usual to taper the sides of the magnets as in fig. 82, page 292. But another point has to be considered. We have in fig. 95, while keeping the armature core of the same cross section, reduced its periphery, and if the length of the wire wound on the armature were the only thing to be considered this would be a decided advantage. But this is not the only thing. We have in the armatures of alternating current machines a considerable amount of energy expended in reversing the magnetism and in generating eddy currents, both of which sources of waste we shall have to consider hereafter. This energy takes ultimately the form of heat, and to keep the temperature sufficiently low a certain radiating surface must be given, proportional to the amount of energy expended per second. Now, in the disc armature the rate of producing heat will be the same as in the ring, since it depends on the induction per centimetre—though not proportional to it—on the weight and on the number of cycles per second. But the radiating surface having been reduced, if the induction remains the same the temperature will rise. To keep it down to that of the ring armature either the induction must be diminished or the radiating surface increased. In either case a greater weight of wire is required both for the armature and the magnets, and this leads us finally to the conclusion that the second machine is, all things considered, somewhat inferior to the first one.

(To be continued.)

ELECTRIC LIGHT PROVISIONAL ORDERS.

BOARD OF TRADE INQUIRY.

(Continued from page 423.)

AT the Westminster Town Hall, the Board of Trade enquiry respecting the many applications for Provisional Orders for powers to light the metropolis in whole or part was continued last week before Major MARINDIN, C.B., assisted by Captain CARDEW.

The enquiry respecting the application of the Metropolitan Electric Light Company was continued from Monday. The agreement entered into by the Metropolitan Electric Light Company with the Strand district local authorities, mentioned by Mr. Claremont, the manager of the company, was already read by Mr. Cripps, the counsel for the company (with whom was Mr. Lyttelton), and it was shown that it varied somewhat in particulars from the Provisional Order asked for.

Mr. BONNOR-MAURICE, of the firm of Bircham and Company, solicitors to the Metropolitan Electric Light Company, was called to give information with respect to the details of the agreement, and in answer to questions he stated that the Strand Board of Works reserved their freedom in the agreement to make fresh arrangements if the company were not to carry out the lighting to the satisfaction of the public.

Mr. MOULTON, Q.C., opened the case on behalf of the Chelsea Electric Supply Company, the Electrical Power Storage Company and the United Telephone Company, observing that he represented the latter company in consequence of the turn which the enquiry had taken since it began. He said that his clients' interests only came into conflict with the other electric lighting companies in so far as the question of area was concerned. Referring to the Act of 1882, Mr. Moulton was of opinion that it was very seriously injured by the overweening importance which was given to certain political considerations as to the position of local authorities, which had the effect of giving undertakers no well-founded ground to expect a fair commercial return for their capital. That, however, was altered by the Act of 1888, and the Legislature had very wisely left the Board of Trade to deal with the matter and to say, where there was a public desire for electric lighting, what was the fairest form of that special legislation which would limit and define the powers of the undertakers in each case. The case of his clients was that the Provisional Order of 1883 was the right one, as it gave even-handed justice to the local authorities and to the companies. The Chelsea company was the only company that was bold enough to obtain and try to carry out an order under the Act of 1882. Now the contest was practically between the two classes of orders—one wanted to adhere practically to the policy of the Board of Trade in 1883, and the other wanted to throw over that policy. That substantially represented the difference between the direct and the alternating systems of electric lighting. The direct system was the cheapest and most convenient. It was the best for the consumer, as it could very easily be made regular, and it was the one that was furthest removed from danger of extinction. Undoubtedly the transformer system was of advantage in dealing with a straggling supply, but the most important question for the consumer was that that system was liable to immediate extinction. Those who were supporting that system only wanted powers over a very large area, and if they obtained those powers, then they would want to supply only those places where they could do it most cheaply and where a considerable profit could be derived, so that in that way they would practically have a monopoly. That policy would, however, be an absolute abandonment of the 1883 order. He stood by that order; and his clients wanted to have a piece of the area fairly to themselves, in order that they might work it with the direct supply. They were willing to bear the burden of electric lighting in places where it was not very profitable, if they also had districts where it was fairly profitable; but they objected to one company having all the cream, so to speak, and leaving the other companies only the skim milk. As to the cost, there was no industry in which the cost of production was so intimately connected with the amplitude of demand. Electric lighting in small quantities was a most expensive luxury, and only as the demand was large could it be produced at a cheap rate. To give one company the monopoly of a large area would not be beneficial to the public. After alluding to the competition which the electric light would meet with from the gas companies, he said there was no reason why electric lighting companies should not be willing to supply the light cheaply—in fact, if they did so it would increase the demand, and so reduce the proportionate cost of supplying that demand. He concluded by urging that the direct supply system was not only safer and better suited to the requirements of the public, but that it was more economical, and that, therefore, the Provisional Order they sought should be granted.

Mr. R. CROMPTON was then examined by Mr. MOULTON. He had given much time to the subject of electric installations, and had designed them for use in London, Vienna, and other places. One at Vienna he had designed was arranged for the supply of from 13,000 to 14,000 lights. At Kensington Station, at which he had been at work, there was a plant which would supply about 5,200 lamps; it had been increased to that from about 300 lamps. The battery system gave absolute security to the public and to the engineers in charge of the installation. The central station at Vienna supplied two of the largest theatres in the world. The authorities there, in consequence of the terrible accident at the Ring Theatre, were more anxious about the safety of theatres than anywhere in the world. But the evidence gained as the result of the experience from the use of the electric light by the storage system was such that all other systems of light had been dispensed with, and there had not been a light go out at either of the theatres since the system was started about two years ago. The witness was then examined as to the details of the direct and transformer systems, and said that with regard to the former there was a possibility of considerable danger owing to leakage from some of the joints which would be necessary in the very long mains. No one could state what would happen from such leakage. There might be a momentary rush of current and a disturbance discharging and scattering copper about much the same as was experienced from a large discharge of accumulators. The witness expressed his opinion that the difficulties in regard to underground mains with a pressure of 1,000 volts had not been satisfactorily dealt with. The weak link in the chain of electric light circuits was the joints, and the weakness increased in correspondence with the increase in the number of the joints. The connection in the low tension main could be safely effected while the current was on.

In answer to Mr. PEMBER, the witness agreed that for scattered districts the transformer system was a valuable one, but he said he had always held that for London the concentrated nature of the lines and the peculiar hours of lighting were such as to render it necessary for the direct system to be used. In regard to the number of generating stations in comparatively small areas, he agreed that the Motor Company's system was the best; and that the best generating unit was about 200 horse-power. There would be no difficulty with careful management in reference to noise, smoke, and vibration under this system. The cost per mile of distributing mains on the low-pressure system was from £900 to £1,700. He had had personal experience of the battery system, but his experience of the transformer system was only second-hand. He based his condemnation of the latter system on the fact that it had only been worked successfully with overhead wires, and he believed the difficulty of underground wires would be very great. The houses near a generating station reaped the benefit of their position in a better light, and that was a fact which applied to all systems, and particularly to a low-tension system. In the system to which he gave the preference the batteries were not used for storage, but for regulating purposes, except in the event of sudden breakdown.

Cross-examined by Mr. HEWITT, on behalf of the Kensington Vestry, Mr. Crompton said there were six companies originally competing in Kensington, but these had since been reduced to four. If there were to be open competition a subway would have to be put down to accommodate these companies, and he did not think that would be practicable.

In re-examination, the witness said he had taken great pains to find authentic cases where alternating systems were worked with the dynamos in parallel, but he had never been able to discover that the system was practised anywhere. If it had been practicable he believed the system would have been largely adopted. It was not possible to pump into a network from different points, and the mains must be supplied from the generating station from one machine. In a network the fact of feeding from many points diminished the size of the mains required for distribution. The

reason of the mains being large was that equal distribution all round was obtained.

Mr. FRANK KING, the chief engineer of the Electric Power and Storage Company, Limited, said he had given much study to the subject of storage batteries. The company had erected batteries and distributing apparatus in the Chelsea district, and had one fully equipped, one in process of equipment, and a third one which had just been obtained. They could now supply 2,000 10-candle power lamps. The batteries were separated into two distinct halves. Each half was charged in series from the generating station. While the charge was proceeding to one half, the other half was supplying what lamps might be required, and that process was repeated until the two halves had been fully charged, when they were both connected on to the supply mains to give the maximum output from the storage station. A battery could not be on a charging and a discharging main at the same time. The networks could all be connected, and the company could at any time have a system of direct supply at the time of maximum demand. If the demand was larger than the present means of supply, it was possible to use an auxiliary, which would not effect any substantial change in what had been already done. The company commenced to erect in the Chelsea district about six weeks ago, and had a generating station actually at work. In his opinion the direct supply, coupled with the use of storage batteries, was by far the best system for house-to-house supply. It was no more costly than the transformer system, and in regard to the quality of supply it was much better. By it, it was possible to work plant at maximum efficiency with a full load. The system was absolutely reliable, safe, and economical, while as to actual loss the transformer and the battery systems compared. The Storage Company were going to supply batteries for the Chelsea Company, and had one generating station and three distributing stations. With these batteries the Chelsea Company could work seven hours a day at the full discharging rate without recharging.

Yesterday, when the enquiry was resumed, Mr. J. K. SHOOLBRED was called on behalf of the Chelsea Company, and said he was carrying out at the present time installations for central station lighting for the Corporation of Bradford. This was essentially a house-to-house supply. He had considered the transformer and the direct supply systems, and he placed both systems before the Corporation. It was decided to have the direct-current low-pressure system, because it supplied not only lighting, but power and facilities for storage. The cost for the generating plant was slightly in favour of the transformer system.

In cross-examination, the witness said that before he reported to the Bradford authorities his experience was limited to the direct system. The maximum supply from these machines would be 1,800 ampères, and they had fixed 115 volts as the pressure for the supply in the town.

Mr. W. H. KNIGHT, an American electrical expert, and at present the consulting engineer of the London Subway Electric Railway Company, said the transformer system had played a very important part in America on account of the many scattered districts; and it was very often put in places where there was no gas supply. It had never been adopted in places where a direct supply was ordinarily used. It was used in suburban and out-of-the-way districts and in small towns. Among the faults of the system were its unreliability, the danger of burning out the transformer, lack of economy, and the irregularity of the light. About 50 per cent. of efficiency was obtained, but it was quite possible to work a transformer up to 95 per cent. The system was safe enough with 1,000 volts, if proper precautions were taken, and if the primary circuit were properly guarded with safety devices. The primary circuit, however, was always a dangerous one, and a friend of his was paralysed, and by now probably dead, through getting a shock from a thousand-volts alternating main. He got his hands on two terminals on the switch, and if he had not been dragged away would have been killed at once. As it was the flesh was burnt off his hands, and he was paralysed. Safety consisted in maintaining a perfect insulation of the primary from the secondary circuit, but that was not always obtained, and the primary very often got into the secondary circuit. He had heard the proposed scheme of the London Electric Supply Company, and that they intended to have underground mains. In his opinion, the joining of these mains would be a source of weakness. The mains of the jointing systems in America were principally overhead. It was extremely difficult to make a joint underground, even when the current was off. He had never known it done when the current was on. In America it had been found to be impossible to get any efficiency with alternating motors, and they were generally found to be exceedingly inefficient. The Thomson-Houston Company, which did the largest business in America, had had sad experience in this respect. Alternate dynamos in parallel had not been successfully worked in America, although this has been known to be a desideratum. Dynamos had been thrown into parallel, but had not been kept there. It was not possible, with independent machines, to carry out that system so as to work a network from many feeding points. He had heard that there were underground mains from the Grosvenor Gallery working efficiently at a voltage of 2,400. The pressure in the American mains was 1,000 volts, and that was considered safe, but the Americans were rather more reckless than English people. There certainly was danger, which was not diminished by the system being properly fitted with fuses. The burning-out of transformers was generally due to a slight—and generally infinitesimal—leakage. He had seen them burn out. Where there was irregularity in the light there were separate transformers to the different houses.

Mr. JAMES SWINBURNE, a consulting engineer, examined by Mr. R. S. Wright, expressed the opinion that several companies in one district would mean a greater cost to the consumers. There would be no question of monopoly, even if an electric light company had a district given to itself, because the light had to compete with a gas company and with petroleum, the sale of which had greatly increased in recent years. Gas was not an effective competitor in America, for several reasons. For one thing it was very dear, and in some parts cost 10s. a thousand cubic feet. The direct system of electric lighting with accumulators was used in large towns in America. The chief disadvantage of the alternating system, compared with the direct systems, was that more plant was needed. The alternating system had, in some ways, an advantage over the direct system in distributing over long distances, but it had the disadvantage that dependence had to be placed upon engines and boilers at the station, instead of on storage batteries at sub-stations. The latter eliminated the chances of breakdown in the mains. Storage was not practically possible with the alternating system. The loss in the transformers was very material when they were put into each house, because the transformers must be large enough to run nearly the whole number of lamps, and when there were only a small number of lamps running for a small portion of the day, there was a great waste of energy always going on. He believed there might be difficulties in regard to the Electric Light Corporation with the telephone companies. The corporation proposed to earth the mains at Deptford. The telephones would be disturbed if there were any leak at the Deptford end, and if there were no leaks there would be a current of about half an ampère going up and down the wires, and that would disturb the telephones. That meant that the Post Office might at any moment veto the whole system. If the transformers were properly designed, the output might be reduced without reducing the efficiency below 70 per cent. It was very doubtful if the electric light would ever compete with gas in regard to price, although he believed the *maximum* price of gas would soon come down. A very great change was coming over the sale of gas.

Mr. T. O. CALLENDER, one of the engineers of the Chelsea Company, said he had had much experience in laying underground mains for electric light, and a company he was connected with had laid hundreds of mains for installations. He detailed the difficulties in laying mains of any sort in London, and said it was, in many cases, absolutely impossible to lay under the footway. There was less difficulty in laying them under the kerbs, but that was the least suitable place for the mains. The difficulties in the roadway were also very great, and if two or three electric light companies were empowered to go down a road he should be very sorry to be the second or the third company. The proposal of the Metropolitan Company to lay a number of mains through one pipe was, in his opinion, a great mistake.

Mr. J. S. RAWORTH, the superintending engineer of the Anglo-American Brush Light Corporation, stated that his company had erected a station at Chelsea, which would have the ultimate capacity of supplying 13 storage stations, each with 2,000 ten candle-power lamps.

General WEBBER said he was the managing director of the Chelsea Electricity Supply Corporation. He had had 19 years' experience of underground lines for the electrical service of the Post Office, and his attention during that time had been drawn to the importance of systems of distribution, particularly in connection with the distribution of electricity for lighting purposes. He warmly protested against the competition and canvassing of several companies in one small district.

The inquiry was again adjourned.

Major F. A. MARINDIN, C.M.G., R.E., as Inspector of the Board of Trade, on resuming:—

Major-General C. S. WEBBER, the managing director of the Chelsea Electricity Supply Corporation, and divisional engineer for the East and South of England—including London—under the Postmaster-General from 1870 to 1879, was examined by Mr. GORDON, and spoke of the difficulty of laying of mains for electric light in one conduit. In the process of drawing for repairs abrasion would be caused; the cables would become matted and stick together; and the whole of the cables would have to be drawn in order to repair only one cable. The Board of Trade only proposed to take concurrent orders in the event of certain obligations not being fulfilled, and by exorbitant prices being charged.

The Witness said he had not seen the letter which the Board of Trade had addressed to the London County Council. He had chosen the Chelsea district as the field of operations for the Chelsea Company, because he lived there and believed that there the light was required. The Chelsea Company desired to show what they could do before asking for powers to extend their area. At one time he was a strong advocate of overhead wires, but when he found that the wires were so thick he had abandoned them. He had had more to do with overhead wires than anyone in the room; and he knew that the opinion had been given that in certain cases overhead wires were absolutely illegal. In 1885 he went to Egypt, and in consequence, the operations of the Chelsea Company were suspended. Under the Act of 1882 there was great difficulty in raising capital for electric lighting companies, in consequence of the clause limiting the time for the operations of such companies.—The Witness was cross-examined at considerable length into the relative merits of the Chelsea and other electric lighting companies.

Major WEBBER continued that the Chelsea Company proposed to have 12 or 13 stations, in order to supply 26,000 lights. But

the output could be considerably increased without increasing the number of stations. The total cost for the 13 stations, including generating plant, would be £30,000. A number of the inhabitants of Chelsea were anxious to be served with electric light by one of the three companies which were competing, and an influential petition was signed by them. They were not particular as to which company supplied the light, so long as they got it satisfactorily from one of them. The maximum number of hours during which light would be required in the shortest of days in the year would be from five to six hours—in some cases from seven to eight hours.

Cross-examined by Mr. GRIFFITHS (representing the City), witness said in the years 1870, 1871, and 1872 he had had considerable experience in the laying of telegraph wire mains in the streets of the City. He had extreme—in fact, exceptional—difficulty in laying the wires for the Postal Telegraph Department.

In reply to Mr. CRIPPS (who appeared for the vestry of St. George's, Hanover Square), witness said that the St. George's vestry had refused their consent to the proposed Order of the Chelsea Company. The refusal was based on the ground that the company proposed to select only the best parts of the parish. Another objection of the vestry was that there were three competing companies ready and willing to undertake the lighting of the whole parish. He preferred districting to competition, as he thought that one company, if given a specific area to serve, would serve the public better than if there were several companies.

In reply to Mr. HEWITT (South Kensington), witness stated that he was in favour in the case of Kensington, of the vestry having power to purchase the Electric Lighting Company in 21 years. If there were several competing companies laying down pipes, he should object to their being all in one conduit. Such a plan would cause differences between the companies as to repairs, and there would be a great deal of trouble with the vestry in consequence. The laying of the tubes by the Chelsea Company would be in such a way as to prevent the probability of danger from the weight of steam rollers. They would be laid in a good foundation, so that the pressure would not cause a strain sufficient to break the pipes. He had heard, of course, of water pipes having to support their own weight in consequence of the ground giving way underneath from leakage or other causes.

Major MARINDIN, in answer to Mr. Hewitt with regard to the insertion of clauses in the provisional orders, said that the question of the introduction of clauses was one to be settled by consultation with the Board of Trade. The inquiry by the Board of Trade was really one more to deal with the question of the policy of districting or otherwise.

Re-examined by Mr. MOULTON, Q.C., Witness said that the unsuccessful attempts at raising capital for the Chelsea Company was before the Act of 1888. Since that Act there had been no difficulty. If they got their provisional order the undertakers would be ready to promptly carry out the order.

Mr. MOULTON, Q.C., then opened the case on behalf of the Electrical Power Storage Company. He said that that company proposed to light the parish of Paddington, and also the district of St. Martin's-in-the-Fields, in the Strand. In the case of Paddington, his clients proposed to take the whole of the parish and to have a generating station so that there would be one complete installation. With regard to the area of St. Martin's-in-the Fields, and the Strand, the vestry did not oppose them, and the terms of the order were extremely favourable to the inhabitants of the parish. Every single street of the compulsory area would be included. They were, however, opposed by the Duke of Bedford, who wanted Covent Garden to be left out; but he (Mr. Moulton) did not think that that request for special exemption required any attention on his part.

Mr. J. IRVING COURTENAY, managing director of the Electric Storage Company, was then examined in support of the case of that company.

(To be continued.)

FOLKESTONE TO BE LIGHTED BY ELECTRICITY.

FOR upwards of ten years a scheme for lighting this fashionable watering place by electricity has been mooted, but until the present time nothing of a very definite character has been arrived at. Last week a special meeting of the Town Council was held for the purpose of considering the matter, and, after an extremely long discussion, it was decided to enter into a provisional contract with Messrs. Crompton, electrical engineers, Chelmsford, to light the western division of the town for five years. This is a result which, as might have been expected, has been accepted as highly satisfactory on all hands. According to the statistics submitted it appears that the present cost of lighting that portion of the town by gas is £1,034 3s., with 4,312 candle-power, whilst the cost to light the same area by electricity will be £1,032, with 51,600 candle-power, so that the light, although a trifle cheaper, is far superior to the present system. Messrs. Crompton have guaranteed the efficiency of their arc light under very heavy penalties, for it is stipulated in their agreement that, should any of their lights fail, a sum of £62 each should be forfeited, the actual price charged for each lamp being £24. Although the scheme has passed the council and has been practically signed and sealed by them, there still remains a difficulty with the local gas company. Their agreement with the corporation does not expire until July 1890, and unless they are willing to allow the agreement to be cancelled, with a fair amount of compensation, Messrs. Crompton's contract will either have to be delayed, or will become invalid. It is feared, however, that the gas company will not give way, but the committee will hold a private meeting with the directors during the week

There is good foundation for believing that as soon as Folkestone is lighted—possibly before—that Dover will entertain a similar scheme. We are somewhat surprised that Folkestone has not moved in this direction long before, for modern improvements of such a nature are essentially necessary to keep a first class watering place well to the front. It is still more surprising to find that just a mere handful of local magnates, with nothing but party interests behind them, should have delayed the matter as long as they have.

STORAGE BATTERY PATENTS.

THE following reaches us just as we go to press, and therefore too late for our correspondence columns. So far as the extracts go they do not seem to strengthen to any degree the credit which was given to Faure in our last issue. It will be seen from our leaderettes that an American contemporary does not wholly agree with Mr. Courtenay:—

"In your last issue you invite comparison between the report of the recent decision given by Judge Coxe in the United States Courts in the suit of the Electrical Accumulator Company of America (which holds the E. P. S. group of patents) *versus* the Julien Electric Company, and the remarks made by the chairman and Mr. Sellon at the meeting of the Electrical Power Storage Company on the 10th instant.

"From the tenor also of a leaderette in the same issue some of your readers may infer that Judge Coxe's decision is in favour of the Julien Company, and that they and others are now free to infringe the Faure patent.

"I would wish to point out that your correspondent has furnished you with a much abbreviated version of the judgment in question, which, in its full text, is some four times the length of the report given. Of the abbreviation of so much matter no complaint can reasonably be made, but it is only fair to call attention to the fact that whilst your correspondent in his summary conveys the impression that it is complete in itself, he contrives to omit every line of the original which tells in favour of the Faure patent, or which indicates the strong views held by the Judge as to its originality and importance.

"Your correspondent's partisanship may be inferred from his uncalled for and untrue preliminary remark 'that the judgment must be regarded as a serious blow to the plaintiffs,' whereas they have not only established all they require and care about, but are now placed incontestably in the position of being able to put under injunction the Julien Company and every other infringing manufacturer of accumulators in the States.

"I cannot venture to suggest that you should print so lengthy a judgment *in extenso*, but I would ask the favour of your insertion of the annexed extracts, which will correct the impression that may exist that the summary given was a full report.

"The sustained claim of the Faure patent absolutely governs the position as to the application by mechanical means of active material to the plates, and to characterise it as 'narrow and restricted' when it covers the whole practical field of work, and the only successful means known of attaining the desired end, is as absurd as it is unjust. As well say that the Edison patent, upon which the United Telephone Company are maintaining their gigantic monopoly, is valueless to them because only one short claim of a dozen words remains out of a mass of some 30 voluminous claims in the original specification, whereas by the decision of the Courts no successful instrument can be made without infringing that solitary claim.

"How much stronger is the case of the Faure patent, of which the only essential claim is completely sustained, without any doubtful or strained interpretation of terms or meanings.

"With regard to the asserted priority of Mr. Brush, the Judge himself says:—'It is not, however, contended for Brush that he applied the active layer to any of his electrodes in the form of a paint, paste, or cement'—and it is a matter of common knowledge throughout the States that his attempts to make batteries otherwise resulted most disastrously to himself and his sub-companies, the batteries proving complete failures, and having to be entirely abandoned.

"ELECTRICAL POWER STORAGE COMPANY, LIMITED.
"J. IRVING COURTENAY, *Managing Director.*"

EXTRACTS FROM JUDGE COXE'S DECISION.

"An electrode for a secondary battery with the active layer applied in this form has many undoubted advantages over an electrode otherwise coated. It can be applied more evenly, it more readily adheres to the support, it does not shift its position, it 'will also pack more closely and readily, and make an adherent layer from which air can be thoroughly excluded, so that uniform contact with the plate and throughout the mass of applied material is secured,' and, finally, a greater and less expensive storage capacity can be obtained."

"There can be little question, upon this proof, that Faure made

his discovery as early as August, 1878. Scientific people at once recognised the progressive step taken, and to him was accorded the credit of an invention of extraordinary merit."

"Sir William Thomson says:—'I knew the Planté secondary battery prior to 1880. Faure's invention was a very great improvement on it, so great as to produce a valuable apparatus for practical work instead of merely an interesting and instructive scientific instrument, which Planté's second battery was. . . . I consider the novelty of Faure's invention to be the application of the oxide of lead to the lead plates before passing an electric current through them, and the rendering of these coatings active by immersing them in the battery liquid and passing the charging current through them.'

"Prof. Barker, the expert witness for the defendants, says:—'To Mr. Faure was due, in my judgment, all the credit which accrued by producing the porous or spongy metallic layer by the method of applying a layer of active material prior to commencing to charge the battery, over that due to Planté for producing substantially the same result by the method of disintegration.' And again:—'I think an electrode formed mechanically would have an advantage of construction in most, if not all, cases over an electrode electrolytically coated.'

"The part of the invention which, *bona fide*, belongs to Faure is an electrode in a secondary battery consisting of a support coated with an insoluble layer of active material in the form of a paint, paste, or cement, so as to be or become instantly spongy, &c. It was this that the scientific world recognised as a great discovery of great merit and importance. It was this that the distinguished Scotch electrician regarded as 'marvellous.' And this was the result of Faure's genius. No one anticipated him. It is honestly his. What he did not invent was an electrode in a secondary battery coated with a soluble layer of active material; neither did he invent an electrode on which the active material is applied by 'galvanic action or chemical precipitation, or otherwise.' The claim is broad enough to cover all these forms probably, and some of them certainly. What he is not fairly entitled to he wishes to give up, and keep what is certainly his own. He does not seek to broaden his patent, but greatly to restrict it."

"After giving the subject the most careful consideration, it is thought that Faure was the originator of the invention just described, and that it would be unjust to him to declare the patent wholly void, if he is willing to restrict it to what is lawfully his own."

THE BIRMINGHAM ELECTRICAL EXHIBITION.

ONE of the great curiosities of the exhibition will be Edison's phonograph. It is hoped to secure the presence of the famous inventor himself at the opening ceremony, or should that prove impossible, on some subsequent date convenient to him. In any case the benefit of Mr. Edison's patronage will be enjoyed, as if he cannot attend in person he has promised to "phonograph" over a few words for the opening function, so that people on this side of the Atlantic with something of a desire to hear the famous inventor's voice will, if they happen to be present at the inauguration, have their wish gratified. Another novelty of the exhibition will be the working of the whole of the moving machinery in the building by electricity, and great interest is certain to be evinced in such a practical application of the new motor to industrial machinery, especially by manufacturers who may be thinking of trying it.

The electrical section, it goes almost without saying, will afford scope for an interesting and attractive display. The exhibits will be grouped in three sections. One of them will consist of a complete display of electric lighting upon all known systems and combinations, and of all systems of electric transmission of power. This should prove a highly interesting section to those who feel any deep concern in the local electric lighting question. Another section will embrace dynamos, arc and incandescent lamps, switches, electroliers, motors, &c.; and the third, telegraph and telephone apparatus, phonographs, electric bells, and all kinds of electric machinery and appliances. Altogether there should be a vastly interesting display of the fruits of a science said to be yet in its infancy. Since the Paris and Crystal Palace Exhibitions rapid strides have been made in electricity as regards its practical application, all which improvements, it is understood, will be shown in the section.

NOTES.

Electric Lighting at Fort-Augustus.—The incandescent electric light, with the most recent improvements and appliances for regulating both engine and accumulators, was installed last week in the Benedictine Abbey and School at Fort-Augustus, on the Caledonian Canal, and will, doubtless, prove a source of curiosity and attraction to the many tourists who pass along this favourite route. A short preliminary run was made on Thursday, April 11th—the Right Rev. the Lord Abbot's feast—when the Provost of Inverness, Sir Henry Macandrew, and other leading men were present. There are in the study hall of the school 24 lights, representing in the aggregate a power of 400 candles. The work has been conducted under the direction of Mr. Neville, of Wellingore, near Grantham.

Tenders for Lighting Galatz.—A despatch has been received at the Foreign Office from Her Majesty's Consul-General at Galatz, reporting that the municipality of that town are prepared to receive tenders for the lighting of the town either by gas or electric light, and that the specifications of their requirements can be seen at the Municipal Offices at Galatz. The tenders must be sent in by May 25th, O.S. (June 6th), and must be accompanied by a deposit of 25,000 francs in cash or Government securities. Applications in respect of this matter should be made in French or German.

The Electric Light in the Suez Canal.—When the electric light was first used for night navigation on the Suez Canal, mail steamers only were allowed to employ it, but this restriction was subsequently removed. Consul Burrell, of Port Said, in a report to the Foreign Office, states that in 1888 there were 1,611 steamers which navigated the canal with electric light, as compared with only 395 in the previous year. The increase is constant, for the figures rose from 86 in January, 1888, to 178 in December, as will be seen from the following table:—

Months.	Ships with Electric Light. 1887.	1888.
January	13 ...	86
February	12 ..	99
March	15 ...	119
April	19 ...	128
May	19 ...	139
June	25 ...	116
July	27 ...	135
August	35 ...	140
September	45 ...	140
October	49 ...	167
November	63 ...	173
December	73 ...	178
Total	395 ...	1,611

The shortest time by a steamer with the electric light for night navigation was 14 hours 55 minutes in 1888, as compared with 15 hours 5 minutes in the previous year.

Cross between Electric Light and Telephone Wires.—On Thursday last the subscribers to the Chatham Telephone Company were considerably startled and alarmed by the continual ringing of the bells connected with the telephones. It was found impossible to stop the ringing and other noises which came from the instruments, and on an enquiry being made it was found that in altering one of the telephone wires it had been placed slightly in contact with the electric light wires, and this caused the unusual disturbances.

A Big Thing in Telephonic Enterprise.—A Franco-Russian company has been formed to establish communication between Berlin, Moscow, Warsaw and St. Petersburg.

The Telephone at Helensburg Hospital.—The National Telephone Company have intimated to the Commissioners of Helensburgh their readiness to connect the hospital with the offices of the Sanitary Inspector, free of cost.

Long Distance Telephony.—An interesting long-distance telephone experiment is about to be tried—namely, the installation of the telephone between London and Paris. The idea emanated with M. Coulon, director of the French Posts and Telegraphs, who talked the matter over with the Post Office officials the last time he was in England, his overtures on the subject having been well received by the English engineers. The study of an operation of this importance, however, is of great delicacy. Specialists see certain difficulties which will have to be overcome before the project can succeed. An engineer has been designated by M. Coulon to commence the study of this new telephonic communication and give an account of the conditions under which it can be established. We hope shortly to lay fuller particulars of this scheme before our readers.

King in Telephones.—At a recent meeting of the Telephone Company of Ireland, the chairman, in a passing reference to Mr. J. B. Morgan, of the United Telephone Company, described him as "the king in telephones." Quite so, says the *Financial News*, King Log.

The Telephone and the State in France.—The French Committee appointed to examine the project relative to the telephones has chosen M. Bernier as its president and M. Georges Cochery as its secretary. The committee have heard the various opinions expressed in the different offices, and from this it appears that its members are unanimously in favour of the Government project, two members alone reserving their assent on a few points. The committee has decided to hear M. Tizard, Minister of Commerce, and M. Coulon, Director-General of Posts and Telegraphs.

The Anglo-French Telegraph Cables.—A decree has just been issued ordering the carrying out of the agreement arrived at between France and England. By the terms of the agreement, the two Governments will either purchase the five following cables:—Calais-Dover, Boulogne-Folkestone, Dieppe-Beach Head, Havre-Beachy Head, and Puori-Jersey, or, if those cables be not purchased, proceed to purchase and lay down new four-conductor cables in a sufficient number to assure, under the best possible conditions, the telegraphic relations between the two countries. The conditions and mode of purchase of the said cables or the substitution of others, as well as the conditions and arrangements for the laying and working of the cables, will form the subject of a special convention between this country and the French Administration on the basis of a co-proprietorship of the cables and an equal division between the two countries of the expenses of the laying down and working.

Telegraph Extension in France.—The French Telegraph Administration proposes to join Paris and the suburbs by an electric network, which is to be more important and developed. The first telegraph lines to be constructed with that object in view will be those from the Porte of Courcelles to Lavallois-Perret and from the Porte of Maillot to Puteaux (Quai National). This is to be carried out without the usual legal formalities, and already details of the lines in question have been addressed to the municipalities interested.

The Society of Telegraph Engineers and Electricians.—The next ordinary general meeting will be on Thursday, April 25th, 1889, when a paper "On Lightning Conductors" will be read by Prof. Oliver Lodge, F.R.S.

Overhead Wires in New York.—The Mayor of New York has ordered, a Reuter's telegram says, the removal of the overhead telegraph wires and the poles supporting them along Broadway, from Fourteenth to Thirty-fourth Street. The work of removal was to commence on April 16th. A later telegram of the 17th inst. says that, owing to the removal of the said wires, Madison and Union Squares, and the immediate vicinity, were left in darkness.

French Phonograph Experiments.—M. Bertrand has just announced to the French Academy of Sciences that M. Mercadier had succeeded in the experiment already successfully accomplished by Mr. Edison in America, and which consists in repeating by a phonograph the words emitted by the aid of a telephone.

Long Underground Cable.—A long-distance underground telegraph cable is said to be about to be laid between Washington and Boston, Mass., by the Spaulding Telegraph Company. General Manager John G. King submitted a form of application to the commissioners for the necessary permits to enter the capitol with the cables. His letter states that Washington, Baltimore, Wilmington, Philadelphia, New York, Boston, and other cities will be connected, and they will be given much more constant, uninterrupted, and cheaper service than is possible by overhead wires. The cable will be laid in a 6-inch cast iron pipe, laid one foot below the surface of the ground, and will contain from 75 to 150 copper wires, each insulated.

The Fatal Explosion at the Electric Supply Works at Deptford.—On Saturday afternoon an enquiry was held at Deptford by the West Kent coroner with respect to the death of Joseph Selway, who was killed by the bursting of a boiler pipe at the London Electric Supply Corporation's premises at Deptford. Evidence as to the identification and the death of the man in the hospital having been given, Mr. Stephen, the resident engineer to the corporation, stated that the engine, the steam pipe of which burst, was of 1,500 horse-power, and was supplied by Messrs. Hick, Hargreaves & Co., of Bolton. Its erection was not quite completed. On Tuesday last Major Marindin, with Captain Cardew and Mr. Ferranti, inspected the works. One engine ran for about 40 minutes. Subsequently witness went to show some gentlemen round the place, and when returning he heard a sound of rushing steam. The place became so full of steam that nothing could be distinguished; but as soon as it was cleared away he went towards the basement, where he saw a fitter named Atherton was being carried up. Witness then went towards the deceased, who was being picked up out of a square hole about 28 feet from where he had been standing. Another man named Sharrocks was also very seriously injured. Witness produced a copper pipe which had burst. It was 5 feet long, 9 inches in diameter, and about ¼ inch thick, and witness's theory was that the explosion was caused through a bad joint in the brazing of the copper bend, perhaps assisted by water in the steam pipe. He could now see two places where the pipe was defective, but a fortnight ago there was nothing to show any defect. Mr. Donald Urquhart, foreman engineer, said that Sharrocks had instructions to start the engine as soon as he thought everything was ready. Witness went to the boiler to put some water in, and he then heard a rushing noise, followed by two sharp snaps. Witness then ran and shut off the steam. The coroner said the action of the witness was very creditable, and probably saved the lives of all the others present on the works. Witness (continuing) said he now saw two defects in the copper pipe. At one of the defects the pipe began to rend. Witness did not believe the pipe had been properly tested. If a proper test had been applied it was probable the defects would have been discovered. The pipe was not tested in its bent state. At this stage of the proceedings the enquiry was adjourned with the object of securing the evidence of the injured men.

Melbourne Exhibition.—Messrs. Felten & Guilleaume have obtained a first-class order of merit, with special mention, in the electrical department of the Centennial International Exhibition at Melbourne.

Honours for a Telegraph Superintendent. — The Queen has appointed Mr. Rayner Childe Barker, Assistant Superintendent of the Telegraph Department of the Government of India, to be a Companion of the Order of the Indian Empire.

Personal.—We are requested by Mr. J. Slater Lewis to state that he has resigned the managing directorship of the Telegraph Manufacturing Company, and that all correspondence intended for him should be addressed to his private house at Helsby, near Warrington.

The Elieson Sale.—The patents, properties and effects of the Elieson Electric Company, Limited, were offered for sale on Wednesday by Messrs. Wheatley Kirk, Price and Goulty, but no bid being made for lot 1 or 2, the auctioneer withdrew.

City Commission of Sewers.—At the instance of the committee it was resolved that the officers of the Commission should be assisted by counsel and by Mr. Preece, F.R.S., of the General Post Office, in the electric light enquiry now being made by the Board of Trade.

Promotion in the Postal Telegraph Department.—Mr. Herbert Joyce, Assistant Secretary at the Post Office, has, it is announced, been appointed Third Secretary in place of the late Mr. C. H. B. Patey. The Assistant Secretaryship has been filled by the promotion of Mr. J. C. Lamb, who will have complete secretarial control of the Telegraphs Department.

Edinburgh Mathematical Society.—The monthly meeting of this Society was held last Friday in the Edinburgh Institution, Mr. A. Y. Fraser, vice-president, in the chair. Papers by Messrs. Charles Chree and R. E. Allardice were read, and Messrs. A. Y. Fraser, J. T. Morrison, and W. Wallace discussed the question of laboratory work in electricity for large classes.

International Novelties Exhibition.— What is announced as the only exhibition in London, 1889, is to be held in the Great Central Hall, Holborn, opening on the 29th of May. The main object will be to place on view the latest inventions and the leading novelties and improvements produced in every branch of manufacture at home and abroad, and the committee promise to use great care to admit only such exhibits as are of the most recent and improved design. Class 4 will be devoted to exhibits relating to electricity and its applications. The manager of the exhibition is Mr. T. Vincent Riordan, F.S.A.

The Government as Electrical Engineers.—The manufacturing Government departments already prevent a good deal of work falling into private hands, without any corresponding benefit to the public purse, and a new departure is now being made at Portsmouth Dockyard. It is announced that dynamos are about to be constructed there for some of the vessels in the Royal Navy. This means a loss to some of our dynamo makers, and it is exceedingly doubtful whether the machines to be turned out will be either more efficient or cheaper than could be obtained from a private firm.

NEW COMPANIES REGISTERED.

Fireless Engine Company, Limited.—Capital £50,000 in £10 shares. Objects:—To carry on business as mechanical and electrical engineers, machinists, iron-founders, &c. To acquire the letters patent No. 7,956, dated 15th June, 1886, granted to Patrick Jay McMahon for improvements in method of utilising ammoniacal gas as a motive power, and also No. 10,897, dated 9th August, 1887, granted to Alfred Julius Boult for improvements in or relating to ammoniacal gas generators, motors or cars; to construct hydraulic, electric or other works. Signatories (with one share each): *J. Holden, *J. Crighton, *R. Crighton, G. C. Peel, J. T. Ford Bishop, M. Peel, all of Manchester; Wm. Druyff, 7, Goldhurst Road, South Hampstead. The signatories denoted by an asterisk are the first directors; qualification, £1,000 in shares or stock. The company in general meeting will determine remuneration. Registered 9th inst. by Waterlow Brothers and Layton. Registered office, 1, Booth Street, Manchester.

British Tanning Company, Limited. — Capital £70,000 in £1 shares. Objects:—To acquire and work the letters patent No. 9,515, dated 5th July, 1887, granted to Eugéne Worms Jean Balé for an improved process and apparatus for tanning by the aid of electricity. Signatories (with one share each): H. Hodge, 17 and 18, Basinghall Street; S. Hoyes, 23, St. Swithin's Lane; D. C. Lee, Thame, Oxon; H. Henry, 4, Comberton Road, Upper Clapton; R. M. Rands, 46, Queen Victoria Street; S. G. Pailthorpe, 1, Courthorpe Road, Hampstead; W. R. F. Sweny, 52, Queen Anne Street, W. The signatories are to appoint the first directors; qualification, £250 in the capital. Remuneration, £800 per annum, and in addition 5 per cent. upon the net profits of each year in which the dividend is 10 per cent. or upwards. Registered 10th inst. by Sanderson, Holland and Adkin, 46, Queen Victoria Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Sudworth and Company, Limited.—The registrar of Joint Stock Companies has received notice that on the 18th of February a meeting of the shareholders in this company was held, at which an account was given showing the manner in which the winding up of the company has been conducted and its property disposed of. The company was registered September 14th, 1887, to take over the business of electrical engineers, carried on at Falcon Works, Bentham Road, South Hackney, by Messrs. Sudworth and Falkenstein. The nominal capital was £5,000 divided into 2,031 preferred and 275 deferred shares of £1 each. 2,000 shares were issued as fully paid, and £306 was received in payment of calls on the remaining shares. A meeting was held last August when it was resolved to wind up, it having been proved that by reason of its liabilities the company could not continue its business.

Railway Automatic Electric Light Syndicate, Limited.—An agreement of 7th ult. between Dixon Hy. Davies, of Leeds, John Tourtel, of 281, Uxbridge Road, of the first part, and James Ernest Spagnoletti, and Joseph Crookes, of Uxbridge Road, of the second part, W. H. England, of Leeds, of the third part, and this company of the fourth part, confirms the provisional agreement of February 14th, whereby the company purchase an invention for effecting by insertion of a coin in certain apparatus, the production of electric light for a certain time, the consideration being £350 cash, and £5,000 in fully paid shares. Registered office, 5, South Parade, Leeds.

Dixon & Corbett & R. S. Newall and Company, Limited (Telegraph, telephone and electric light cable manufacturers, &c.).—An agreement of the 11th January cites that Mr. Isaac Morgan of Dumfries Place, Cardiff, has agreed to transfer to the company a mortgage he holds on certain leasehold property at Cardiff, in the occupation of the company, in consideration of £500 payable by the allotment to him of 50 fully paid 5 per cent. preference shares of £10 each.

Akester Electro-Motor and Accumulator Company, Limited.—The annual return of this company made up to the 2nd inst. was filed on the 9th inst. The nominal capital is £5,000 in £1 shares. The whole of the shares are taken up, 3,500 being considered as fully paid. Upon 1,500 shares, 16s. per share has been called, the calls paid amounting to £824 16s., leaving £375 4s. unpaid. Registered office, 50, Holborn Viaduct.

Priestman Brothers, Limited.—An agreement of 5th ult. refers to the purchase by the company of the business of Priestman Brothers, of Hull, and of 73A, Queen Victoria Street, E.C. The purchase consideration is £150,000, payable £5,000 in cash or debentures of the shares and the residue in fully paid shares. The purchase includes the license from the Petroleum Engine Company for the exclusive right to manufac-

ture the "Priestman oil engines" under the Priestman's, Hume's and Eteve's patents for the United Kingdom, India and the Colonies.

Corinthian Electro-Medical Battery Company, Limited.—An agreement of 26th ult. provides for the purchase from C. Longbottom Hindle, of 108, Stockwell Road, of the invention known as Ford's Automatic Electro-Medical Battery, and the provisional protection granted for the same, together with any patents that may be obtained for France, the French Colonies, and the United States of America; also 23 of the said batteries in working order, and the copyright of the design and registered trade mark in relation thereto. The purchase consideration is 20,000 fully paid shares of £1 each. Registered office, 1, Gate Street, Lincoln's Inn Field's.

Dermatine Company, Limited.—An agreement of 28th ult., filed on the 1st inst., provides for the purchase by this company of the assets and undertaking of the British and Colonial Dermatine Company, Limited. The purchase consideration is issue to the liquidators of the old company of 8,681 shares, in the new company credited with £4 7s. 6d. as paid upon each, leaving a liability of 12s. 6d. per share, and the payment of the debts and liabilities of the old company, and the costs of winding up and of forming and registering the new company. Registered office, Herring Street, Neate Street, Camberwell.

Hammond Electric Light and Power Supply Company, Limited.—A meeting of this company took place on the 10th inst., when an account was given as to the manner in which the winding up has been conducted and the property of the company disposed of. The company was registered 20th January, 1882, with a capital of £250,000 in £5 shares, which was subsequently increased to £330,000. The last annual return is made up to the 1st May, 1884, and this document sets forth that 56,133 shares were taken up, upon which £279,580 had been paid, £1,085 remaining due thereon. On the 17th June, 1885, it was resolved to wind up, it having been proved that by reason of its liabilities the company could not continue its business.

Midland Electric Light and Power Company, Limited.—An order of the Chancery Division of the High Court of Justice, dated 10th inst., directs that tne register of members of this company be rectified by removing the name of Arthur Chamberlain, of Birmingham, as the holder of 2,074 ordinary shares of the company.

LEGAL.

United Telephone Company, Limited v. New Telephone Company, Limited.—This was a motion treated as the trial, the defendants submitting to have a perpetual injunction granted against them restraining them from infringing, as to receiving instruments, Bell's patent, and as to transmitting instruments, Edison's patent, the plaintiffs not pressing for damages. The Attorney-General (Sir R. Webster, Q.C.), Mr. Aston, Q.C., and Mr. Micklem appeared for the plaintiffs; Mr. Bousfield for the defendants. The Attorney-General said he wished it to be known that the plaintiffs did not desire to press hard on persons who had purchased infringing instruments, and if such instruments were delivered up within a month, the company would not proceed for damages against such purchasers.

Winfield and Co. v. Crompton and Co.—Before Mr. Justice North. This was a most complicated action for an account relating to certain adventures connected with electric lighting, among other matters the installation and supply of electricity for the purpose of lighting the Leeds Town Hall. The plaintiffs are manufacturers of copper wire and other things, of Birmingham; the defendants are electrical engineers. The plaintiffs alleged that they had supplied articles at the risk of the defendants by the way of advance, and sought an account on the footing that they were creditors. The defendants, on the other hand, maintained that they were co-adventurers on the terms of an arrangement agreed upon in 1882, and reduced to writing as heads of an agreement. The trial took place at the end of last year. His Lordship this morning gave judgment. He held that the parties had acted on the footing of a partnership regulated by the heads of agreement of 1882, so far as they were applicable, and directed an account on that footing.

CITY NOTES, REPORTS, MEETINGS, &c.

The Indo-European Telegraph Company, Limited.

IN the report for 1888 the directors express their deep regret at the retirement from the chair, after an occupancy of 17 years, of Colonel James Holland, and express their satisfaction at the acceptance of that office by the present chairman, Mr. J. Herbert Tritton.

The company's revenue from all sources for 1888 amounted to £110,327 7s. 7d., as compared with £104,290 18s. 3d. for 1887, showing an increase of £6,036 9s. 4d. The expenses were: on commercial and general account, £28,609 12s. 9d.; on maintenance accounnt £23,783 11s. 10d., including £84 17s. 8d. paid to the Russian Government; total £52,393 4s. 7d., as against £48,620 15s. 3d., an increase of £3,772 9s. 4d. Deducting the above expenses, taking credit for £2,694 15s. 1d., brought over from 1887, and debiting income tax, there remains the sum of £59,283 18s. 7d. From this amount £10,000 has been placed to reserve, and that sum, together with £10,625, amount of interim dividend, have to be deducted, leaving a balance of £38,658 18s. 7d.

The directors propose the declaration of a dividend for the last six months of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income-tax, making in all 10 per cent. for the year, carrying forward £6,783 18s. 7d. to the credit of 1889.

It will be observed that the balance carried over is larger than usual. Provision has to be made, however, for extensive alterations and additions to the system which must be effected during the current year, and the recent interruption of both the company's cables in the Straits of Kertch has also entailed exceptional outlay, so that the whole of the additional amount carried over will be absorbed.

The falling off in the revenues derived from Indian messages upon the reduction of tariff, remarked upon in 1886 and 1887, continued during 1888, but fortunately has again been made up by other traffic.

The following directors retire by rotation, and offer themselves for re-election: Mr. C. W. Earle, and Mr. J. Berenberg Gossler.

Oriental Telephone Company, Limited.

THE ninth ordinary general meeting was held on Tuesday, April 16th, at the Cannon Street Hotel, William Addison, Esq., presiding. The notice convening the meeting was read. In moving the adoption of the report (given in our issue of April 5th),

The Chairman said he congratulated the shareholders upon the steady, though comparatively slow, improvement in the condition of the company. With regard to the balance sheet, the directors thought it better to recommend a smaller distribution than they might have done, in order to form a reserve fund, thereby protecting the shareholders from the possibility of a call being made. This reserve fund they intended investing in such substantial security as might be easily realisable if the money were to be required. This would enable them to extend the business without calling upon the shareholders.

Mr. E. F. Powers thought the sum they intended to take for the reserve fund was too large, and thought it was impossible to further develop the business of the company.

The Chairman said when they took office it was on the understanding that they would endeavour to carry on the business without making a call, and in order to do that they must have a reserve fund. With regard to the extension of the business, they had under consideration one or two fresh places which, in all likelihood, would open up fresh business.

The motion was then carried.

A dividend of 3 per cent., free of income-tax, was proposed by the Chairman, which was agreed to.

The names of Hy. Grewing, Esq., and Thomas Lloyd, Esq., were put forward for re-election as directors; the motion was carried unanimously. The retiring auditors were also re-appointed.

A vote of thanks to the chairman brought the proceedings to a close.

The Direct United States Cable Company, Limited.—The directors have resolved upon the payment of an interim dividend of 3s. 6d. per share, free of income tax, being at the rate of 3½ per cent. per annum for the quarter ending March 31st, 1889, payable on the 26th inst.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 5th, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,171.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ended April 5th, amounted to £3,407.

REVIEWS.

Glimpses of Feverland: or a Cruise in West African Waters. By ARCHER P. CROUCH, B.A., Oxon. London: Sampson Low, Marston, Searle and Rivington, Limited.

Mr. Crouch's "Surf Bound Coast" was a welcome addition to the literature of travel, for it presented a narrative of exploration under novel conditions. In "Glimpses of Feverland" we have to a great extent the same conditions reproduced. The characters of the book, or the most important of them, are engaged in a cable-laying expedition, varying their trying labours by making the acquaintance of the interesting natives of the West Coast of Africa, their habits and customs.

Very little is known about cable-laying outside the two or three companies who are specially engaged upon the work; very little, too, is known of the land of Kings Oko Jumbo and Ja Ja. Consequently Mr. Crouch has opened a new mine, both of information and amusement, to the general reader. Confining himself strictly to facts, either coming within his own observation or imparted to him by residents of character and of long standing, he has many things to tell which are of absorbing interest, and as entertaining as many a novel. Superstition, of course, holds its sway amongst the semi-savages of the West Coast, and many barbarous customs remain, notwithstanding the efforts of missionaries and the "protectorates" established by Europeans. For instance, we read that in some parts of the Niger Delta two human beings are still sacrificed each new moon. Then, notwithstanding that it is the chief desire of a Bonny native to have a numerous offspring, twins, instead of being joyfully welcomed by the expectant father, are regarded as monstrosities, and at once put out of the way by being buried alive.

The practical German and his love for technical training, of which we have heard so much here at home latterly, are *en evidence* on the West Coast, too. The English and several other missions try to instruct the native children in the doctrinal instead of the practical side of our religion; the time not so wasted is devoted to teaching reading, writing, and arithmetic, giving the natives thus educated an exaggerated notion of their capabilities, and unfitting them for any occupation save that of clerks, for whom there is hardly any demand. The Germans, on the other hand, gain the goodwill of the natives by teaching them useful handicrafts, such as carpentering, coopering, and so on, mingling with this instruction as much religion as the native mind is capable of grasping. This plan has been very successful. Trustworthy workmen are turned out, who are in great demand in all the factories down the coast.

The coast over which Mr. Crouch's exploration extended is actually the "feverland" his title states it to be; yet life there seems to possess certain attractions for those who remain long enough to become thoroughly imbued with the spirit of the place, for we read of one gentleman, asked how he liked living at Bonny, bursting out in this enthusiastic strain:—"How do I like it? Why, I've been in Bonny 17 years, and I only wish I had the time to spend there all over again. That's how I like it." Yet, according to our author, this was a man reduced by years of sojourn in this deadly region to mere skin and bones, his eyes burning with feverish brightness above hollow cheeks, and his voice so weak and low as to be almost inaudible. One of the cable party, however, holds a far different opinion as to the advantages of the West Coast as a residential quarter, for he calls it a "miserable region," and bitterly remarks:—"It was never meant for man, or, at any rate, white man, to inhabit."

The author (who, by the way, figures in the book under the name of Bertram, the actual names of all the characters being dropped in favour of fictitious ones), had an entertaining conversation at St. Thomé with a Portuguese gentleman whose ideal way of enjoying himself when in London is to go to the nearest Underground station and ride all round the Inner Circle three or four times without getting out.

We advise those of our readers who are curious to know how cable men spend their time when upon these prolonged trips, and who can appreciate really good descriptions of scenery, manners, and customs, to procure Mr. Crouch's very interesting book.

Journal of the Institution of Electrical Engineers. No. 78. Vol. XVIII. London: E. & F. N. Spon, 125, Strand.

The general contents of this No. are as follows:—"Continuation of Discussion on Prof. Jamieson's Paper on the Insulation Resistance of Electric Light Installations." Communications with reference to the same. "On Certain Phenomena connected with Imperfect Earth in Telegraph Circuits," by A. E. Kenelley, Associate. "Some Electric Lighting Central Stations in Europe, and their Lessons," by Prof. G. Forbes. "Abstracts." Classified List of Articles relating to Electricity and Magnetism appearing in some of the principal English and Foreign Technical Journals during February, 1889.

Joseph Henry and the Magnetic Telegraph. An address delivered at Princeton College, June 16th, 1885, by E. N. DICKERSON, LL.D. New York: C. Scribner's Sons.

The correction of what are assumed to be historical facts is now become so common, that no apology is needed for the publication of pamphlets of the kind. Without disparaging the work of Faraday and others, the author brings forward evidence to show that the discovery of electro-magnetic induction and of the electro-magnetic telegraph was also made by Professor Henry. The argument, however, that if Henry had had all the advantages that Faraday had he would have been equally as great a discoverer, is hardly a logical one, and could be repeated *ad nauseam*. That Prof. Henry was a great philosopher, and one who ranks with the very first of the century, can be readily admitted; the American nation has a just right to be proud of him, and Mr. Dickerson's historical sketch of him will be read with great interest.

SPRAGUE ELECTRIC ROAD AT BROCKTON MASS.

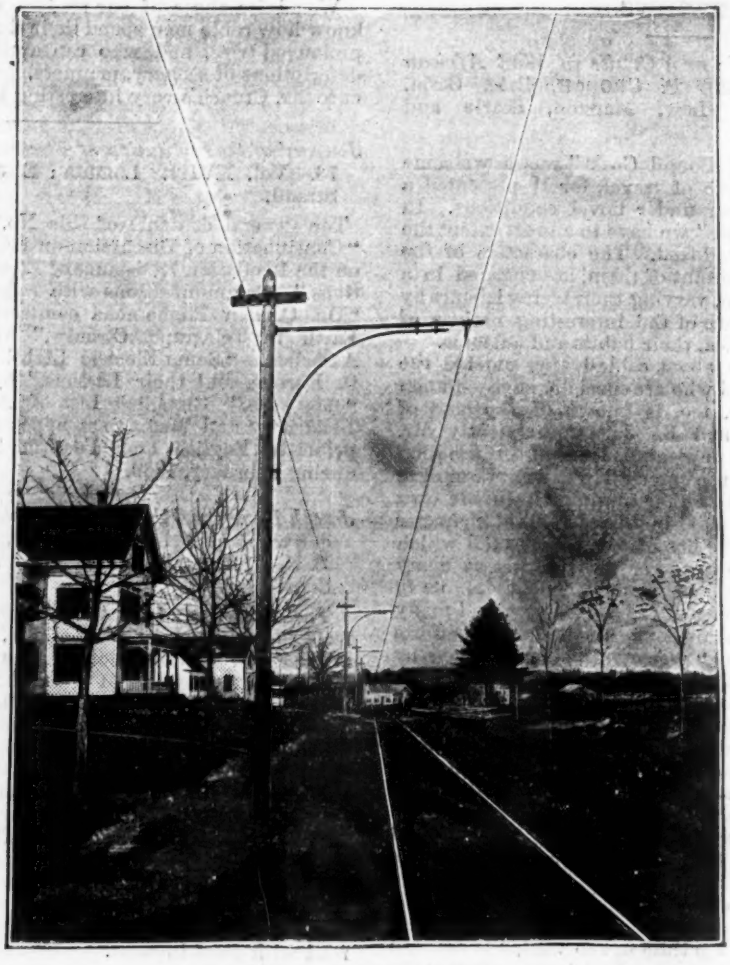
WE take pleasure in presenting to our readers in this issue of our paper two views taken of an electric railway recently installed in Brockton, Mass., by the Sprague Electric Railway and Motor Company of New York. This is the Brockton East Side Electric Street Railway, of which Mr. R. F. Small is president, and which operates four electric cars over four miles of track.

The regular Sprague system of overhead wiring is used, in which a small working conductor, made of silicon bronze, having a very high tensile strength, is the only wire carried over the street, and the greater portion of the current is carried upon a main conductor at the side, and connected to the working at intervals of about every 100 feet.

This road has been in operation for three or four months, giving great satisfaction to the president and directors of the road, as it is said, and carrying a large number of passengers.

One of our views represents the method of bracket support which is in use upon this road, also giving a very good idea of the Sprague method of separate main and working conductors, running to each other. The former reinforces the latter, whose size is independent of the number of cars run or the length of the line.

The second view shows all four cars bunched at the end of the line. This was done in order to test the ability to operate all four cars at the farthest point distant from the power station. The test was perfectly successful, and in spite of the long distance over which the power was transmitted, the cars moved promptly, and attained their usual speed without trouble.



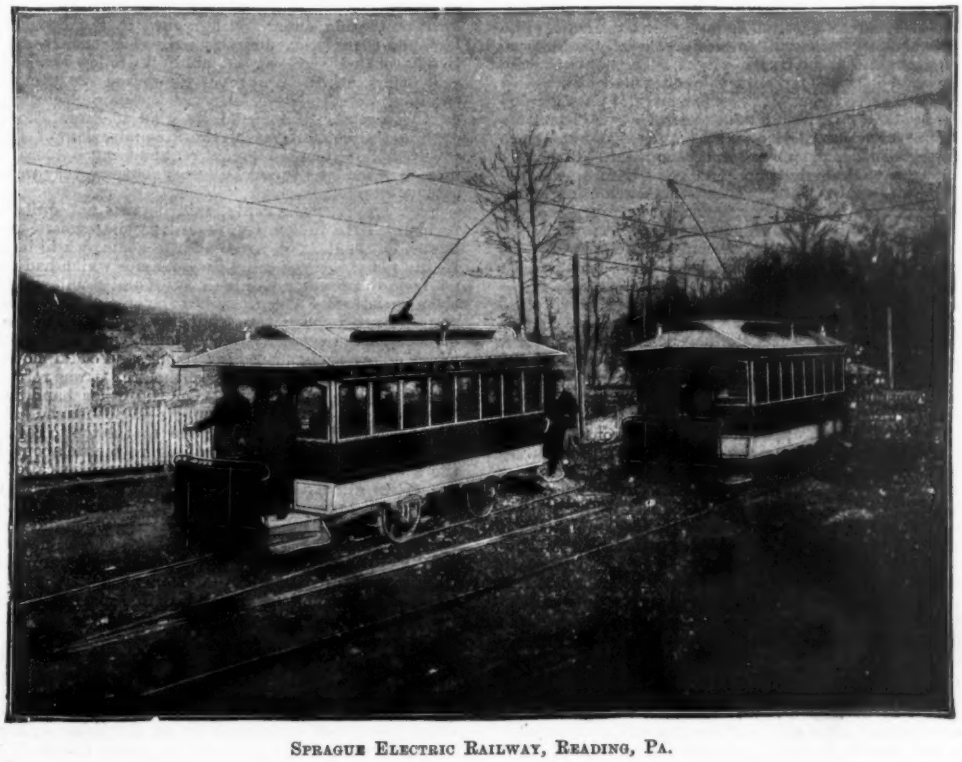
SPRAGUE ELECTRIC RAILWAY—BRACKET SUPPORT.

SPRAGUE ELECTRIC RAILWAY AT BROCKTON—BUNCHING THE CARS.

SPRAGUE ELECTRIC ROADS AT READING AND WILMINGTON.

WE here present views of two recent electric roads, taken from photographs, one in Pennsylvania, and the other in Delaware.

SPRAGUE ELECTRIC RAILWAY, WILMINGTON.



SPRAGUE ELECTRIC RAILWAY, READING, PA.

One of these represents one of the cars upon the Wilmington Delaware City Railway. This railway, which was installed by the Sprague Electric Railway and Motor Company, of New York, has been in operation for about eight or nine months, and the president and the directors of this road have felt so very well pleased with its operation that they have ordered an additional number of cars. The railroad is two miles long, using the regular Sprague overhead system of wiring, with small working conductor $\frac{3}{16}$ths of an inch in diameter, which, according to the Sprague system of electric railways, is the only wire suspended over the middle of the track.

View No. 2 gives a representation of two electric

cars on the East Reading and Black Bear Railway passing each other upon a turnout. This road has recently been installed by the Sprague Electric Railway and Motor Company, and has been in operation only about two months. The road has been operating very successfully ever since its installation, and has been carrying a large number of passengers.

ARC LAMPS AND THEIR MECHANISM.*

By PROF. SILVANUS P. THOMPSON, D.Sc., M.I.E.E.

(*Concluded from page* 432.)

DISCUSSION.

Mr. P. SELLON said it must have been a pleasure to all to listen to Prof. Thompson's wonderfully clear and lucid paper; and the question he had brought forward was particularly interesting just at this epoch of electric lighting, when it appeared about to have a chance at last, when they were really looking forward to a legitimate expansion in electric lighting from central stations, and might hope to see the streets of London and other large towns lighted in a way which would compare with towns in America and on the Continent. The question he had raised about the back electromotive force of the arc, or what was supposed to be the back electromotive force, was a point well known to electrical engineers, and several theories had been advanced to explain the phenomenon: it would seem as if it was a number of thermo-electric couples between what the professor told them was the point of volatilisation necessary in an arc light, and the atmospheric temperature, so as to make up the 39 or 40 volts of the back pressure. With regard to the classification which Prof. Thompson had given, he might perhaps be prejudiced in the matter, but he thought the distinction drawn between clock-makers' and sewing-machine makers' lamps, and engineers' lamps, was rather hard. He always classified lamps in his own mind as broadly divisable into two kinds—the arc lamp, which was non-retractile, and which was generally a lamp with electromotive force feed alone, the striking being done by an independent magnet or mechanism, the effect of which was that, as the release of the feeding mechanism required very little power, lamps of that order were exceedingly sensitive; and, speaking broadly, they had far greater steadiness than in the other class, in which the electromagnet had to do the double operation, not only the heavy work of striking the arc, but the light work of feeding the mechanism. Both these had their advantages. The latter were retractile; the other class were non-retractile, but, speaking generally, were more likely to give an absolutely unwavering light. The non-retractile might be called an egoistic lamp, and the other he considered as an enlightened altruistic lamp. The egoistic one, if put on a circuit with an altruistic one, would take great care to select for itself the amount of electromotive force required, and the more virtuous altruistic gentleman suffered in consequence. The effect had been that many altruistic lamps had got a bad name undeservedly, because the egoistic lamp would either burn exceedingly well or not at all, and unless the electromotive force furnished by the dynamo was sufficient for all the lamps on the circuit, they would go out entirely; but the altruistic ones would adapt themselves to varying conditions, and burn, though not so well, with an insufficient current; and as the tendency of human nature was to take as little trouble as would produce a passable result, want of attention had often given the latter a bad name. It was a case of external neglect rather than one proper to the lamp itself. Prof. Thompson's course of reasoning seemed to have led him to a watt-regulated lamp as the beau ideal of what an arc lamp should be; and no doubt that was perfectly true, following that line of reasoning; but surely it should be remembered that arc lamps invariably ran either with a constant electromotive force or with constant current, and if you are dealing with either one set of conditions or the other, what function did the watt regulator fulfil? An arc lamp, in order to burn reasonably well, must have somewhere between 45 and 50 volts at the terminals, and it was no satisfaction to that lamp, if the electromotive force fell to, say, 40 volts, to know that it would raise the current up so as to bring the product of the electromotive force by the current to a given number of watts.

Mr. ROGERS also thought Professor Thompson had been a little hard on some of the clutch lamp makers; though it was some comfort to hear that if the lamps were rough, they were effective. All who had to do with the placing of lamps of that rough and ready class, knew that there were certain conditions which Professor Thompson had explained, which did not appear at first sight, which had to be attended to. However well you might make your moving part, after a time either the rod was abraided, or dirt got in and impaired the steadiness of working. He had experimented with some 20 or 30 different forms of clutch, and always found that was the main difficulty to get over. The motor driven lamp referred to last he had been much struck with, but should like to ask one question about it. He believed some eight or nine lamps of the motor type had been made, but after some time there was a defect, which he thought he had noticed in that one; although it was exceedingly steady. After a time the lamps got warm, and then there was a tendency to retardation in the motor. In watching the lamp, he thought the later feeds—and there seemed about a couple of dozen feeds in all—were a little retarded, the arc became a little longer before it began to feed, but he did not know whether it was due to the cause he had suggested. One such lamp was in the Crystal Palace Exhibition, and he rather fancied it had the same defect, but this was certainly the most perfect thing in the shape of feed he had yet seen.

Mr. R. J. WILLIAMS said he was not connected with any company, but he had had a little experience in putting up lamps, and he must say that he had found what were termed the rough and ready lamps the best in some cases, simply because you were obliged, in foreign countries, or in exhibitions, or in cases of emergency, to employ the workmen you could get on the spot, who were not always very skilled, and were often working under conditions in which dust and dirt were unavoidable; and in such cases the sewing machine type (American) of lamp, did its duty quite as well as any other, and, he thought, rather better, though he would not state that positively. He had chosen the Brush type of lamp, or one similar to that, for the lighting of the Kremlin at the time of the coronation of the Czar. He used them with rough Russians in the coldest of climates, and again in the hottest of summer weather, and, under both conditions, they did their makers credit.

Mr. MORDEY pointed out that lamp manufacturers had to keep before them the desirability of making one lamp which would do for every purpose. Many of the lamps so clearly described by Prof. Thompson, excellent as they were, were only suitable for use under one set of conditions. He thought that a good arc lamp ought to be able to burn in series, in parallel, in multiple series, with constant current, with constant electromotive force, and with an alternating current or a continuous one. Manufacturers should be able to make one lamp which would do all these things with only slight modifications in detail. He had been connected with electric light a great deal, but he had never tried to invent an arc lamp. He was rather proud of the fact. His reason was, that having been connected with the "Brush" Corporation, and having found that the "Brush" lamp, given good carbons and fair treatment, cleanliness and proper conditions, would burn at least as well, and taken all round, better than any other, he had thought it as well to leave it alone so far as its general principles were concerned.

Mr. WYLES said the Brush lamp burned very well at first, but then the rod got a little speckled; and he thought the fault lay in sending the current through the washer; and that if the connection were so arranged as not to have a moving contact, it would be better. The new form of Brush lamps was a great improvement on the old ones. With regard to the Brockie-Pell lamps, he found them work admirably; the electromotive force was practically constant, and he did not quite follow Mr. Sellon when he said they robbed the others if worked on the same circuit, assuming them to be working with the average electromotive force on the circuit. He should be glad if Prof. Thompson would explain the connections of the Maquaire lamp. His experience was that the Crompton lamps required much more skilled workmen to attend to them, but they burned very well if properly attended to.

Prof. THOMPSON, in reply, said he was not quite sure that he understood Mr. Sellon with regard to the egoistic and altruistic lamps, but he did not agree with what he took to be his meaning. He did not think you could divide lamps which had only one magnet from those which had both series and shunt magnets, and call them egoistic and altruistic. In the case of a constant potential, you did not require two magnets to get a retractile effect. For example, there was the Gülcher lamp, with a magnetic clutch, in which a single magnet fed and struck, and could move up or down, according to the requirements of the arc. It was retractile, and yet there was only one magnet. On the other hand, he could point to a lamp which had two magnets—a pot magnet at the bottom to strike the arc, and another one at the top to regulate the feed with a shunt—which had nothing retractile about it, although there were two magnets. Why one should be called egoistic and the other altruistic he did not know. One would undoubtedly adopt itself to the conditions of the arc, and the other would not, but it was the altruistic one in this case which did not adapt itself to the surrounding conditions, and the egoistic one which did. He must beg pardon of Mr. Sellon and Mr. Rogers for having dared to compare the lamps of the companies they represented to the work of clockmakers or sewing machine makers, but he would ask them whether the criticism was not in the main just; whether the class of lamp, as a whole, had not that characteristic about it. It was quite possible to have a sewing machine well made, and quite possible to have a clock which was a magnificent piece of engineering, not thrown together like the clocks which inundated the market from abroad. But he would remark that not only was the voltaic arc itself discovered by an Englishman, Sir Humphrey Davy, but the first rack train lamp was invented by Staite in 1847, and the first clutch by Slater and Watson in 1852; whilst, as for clutch wheel lamps, we must claim them all. They were all equally English from this point of view; and it was perhaps rather characteristic of the people where they were used, than of the inventors, that the Americans seemed to have adopted the clutch and the Continentals the rack and train. It was not for him either to condemn or to approve without reserve any one

* Read before the Society of Arts on Wednesday evening, 6th March, 1889.

lamp, or to say which, of all he had mentioned, he gave the preference to. If any one wished to know which he considered the best, they would have to read very carefully between the lines of his paper; as a matter of fact, there was no best lamp, or, at any rate, he had not yet found it; but there were some which, take them for all in all, might be said to be as good as any other in the market, and there might be two or three for which that claim might fairly be made. Mr. Sellon objected to his notion that regulating by the product—by the watts instead of the volts or ampères—was possible—because arc lamps were habitually worked with constant potential or constant current. He quite agreed that theoretically you got over the variation in the quantity of energy supplied by having a mechanism which provided for the regulation of the one factor; but there were certain lamps which did not depend either on the current or on the potential, but on the difference between the two; the lamps being differentially wound. In fact, the differential winding, to keep the difference between the two quantities, instead of the product, constant, was one of the things which had been looked upon in the past as an important patent. Did not Mr. Sellon's argument apply still more strongly to such a form of lamp. If one of two factors of the product was constant, and you kept the difference between that and the other constant, you virtually kept the product constant; but if, with one of the two supposed constant, you could not depend on the dynamo, then the difference between that and the other being kept constant would not regulate the light at all; the difference failed to have any meaning if you could not rely on one of the two things, between which the difference was to be taken, being constant. The attempt at product regulation was therefore essentially better than regulation by difference. With reference to the connections of Maquaire's screw lamp, it was difficult to explain them off-hand, but he would endeavour to give some of the method. The large magnets must be taken as being wound in the main circuit with thick wire; but when you had got half way through the winding, there was a branch taken off, which went to one of the brushes of the armature. This had a comparatively fine wire coil, and was virtually a voltmeter. This was, therefore, necessarily a product regulating lamp; because if the armature were a voltmeter, the field magnets were in the main circuit, and were a sort of ampèremeter, the force which pulled the thing round would be proportional to the product of the two. But this was not a wattmeter in the proper sense of the word, because the armature was not taken as a shunt to the whole arc; it was only taken as a shunt to half of the coils of the field magnets. (Prof. Thompson further explained the mechanism of the lamp by the aid of a diagram.) Mr. Rogers said he thought that he had watched the lamp feed about 20 times, but he thought he must have been mistaken, because the little armature did not remain constant more than 10 seconds together when the lamp was in operation, the regulating wheel was continually in motion, the one revolution of the wheel made an extremely small difference in the position of the carbons. (The lamp was again put in operation to illustrate this.) He did not think the heating of the motor, as suggested, would seriously affect its performance, and he did not see why it should affect this mechanism any more than the operation of a clutch. He thoroughly believed in a rough and ready lamp for rough and ready work; but rough and ready work such as was admissible in illuminating the Kremlin or lighting a "city" in the back woods of America, was not the kind of work which would be sufficient when a contract for lighting the City of London had to be fulfilled.

The CHAIRMAN, in proposing a vote of thanks, said all Prof. Thompson's work was characterised by great patience and immense industry; some of the papers he had read in that hall had become quite classical, and, in particular, the one on dynamo machinery had developed into the best book on dynamos in the world. One or two new points had been raised that evening which required a considerable amount of development. For instance, this theory of the back electromotive force, which had occupied as yet the labours rather of the laboratory than of the practical man, had behind it an immense amount of practical importance. At present, they did not know to what to attribute it, and it was extremely variable. The lamps on which the principal experiments had been made were Brush lamps, and the best experiments were those made by Prof. Cross and Mr. Shepherd, at Boston, on Brush carbons. Those made by Mr. Edlund were on Carrè carbons from Paris, but he knew it to be a fact that this back electromotive force was extremely variable, according to the quality of the carbon. Mr. Crompton, some years ago, made a series of observations on the light-giving qualties of various kinds of carbons; his researches were published in Mr. Gordon's book on electric lighting, and he there brought out some astonishing results. For instance, with the same amount of current the amount of light varied very much indeed. Those who had the opportunity should certainly attack this question, and those who did would find that in regard to the quality of carbons there was a wide field for experiment. Prof. Thompson had not said much on the immense importance of having steady arc lamps for alternate current working, but that was coming to the front with giant strides. We were on the verge of a tremendous boom in electric lighting, and before 12 months were over he believed every one would be astonished at what was done in London. He knew at present of 10 central stations which were in progress, most of which would be at work within a year, and he had every reason to believe that by that time all the principal thoroughfares in the City—with the Strand and Piccadilly—would also be illuminated by arc lamps. The selection of these lamps would involve a great deal of care and consideration; and although some remarks had been made on Prof. Thompson's classification, he thought it might be justified. Clockwork was but machine or engineering work, and he ventured to think that the highest compliment which could be paid to any class of work was to compare it to a sewing machine. There was no piece of mechanism in the world so wonderful as a sewing machine. They were worked for years in kitchens and all sorts of places by unskilled persons of all kinds, and did their work well. Six months ago he had the first graphophone sent to this country; it was exhibited at Bath; from there he brought it to his office, and it had been in constant use since September. It had been handled by everyone who liked, and when he took it home at Christmas, it was worked by all his children, and by everyone who saw it, and it had never been out of order once. That instrument was a grand specimen of sewing machine work, and a more beautiful piece of mechanism was never brought to this country. He trusted this paper would become as classical as its predecessor, and that it would develop into a handbook on arc lighting.

The vote of thanks having been passed unanimously,

Prof. THOMPSON, in response, said he would take that opportunity of thanking all the gentlemen, too numerous to mention, who had so kindly given him information, and lent him lamps for exhibition.

The following lamps were exhibited, and most of them shown in operation:—Serin, Brush-Sellon, Crompton "E," Brush (2), Thomson-Houston, Thomson-Rice, Waterhouse, Lever, Gülcher, Jolin, Fein, Crompton-Crabb "D.D.," Statter, Brockie (Projector), Pilsen, Rogers, Maquaire, Siemens (Contact), Siemens (Projector).

PROPOSED ELECTRIC LIGHTING AT BRIGHTON.

BOARD OF TRADE INQUIRY.

MAJOR MARINDIN, C.M.G., R.E., opened an inquiry on behalf of the Board of Trade on Thursday last week at the Town Hall, Brighton, in reference to an application by the Brighton Electric Lighting Company for a Provisional Order under the Electric Lighting Acts, 1882 and 1888, authorising them to supply Brighton and Hove with a system of electric lighting. Mr. Shire Wills, Q.C., appeared for the promoters of the company; Mr. Boxall (instructed by Messrs. Rees and Frere) represented the Corporation, who are opposing the application; and Mr. R. W. Wallace (instructed by Messrs. Fitzhugh, Woolley & Barnes) watched the proceedings on behalf of the Hove Commissioners.

Mr. SHIRE WILLS, Q.C., in opening the inquiry, said that the company which he represented had for several years past supplied Brighton with the electric light with great advantage to the town. Objections, however, having been made to the overhead wires, a Board of Trade inspection was carried out by Colonel Armstrong, as the result of which it was recommended that the company should apply for a provisional order, so as to enable them to carry their wires underground. He much regretted that in making this application accordingly the company had as yet been unable to gain the consent of either the Brighton Corporation or the Hove Commissioners, but he hoped to be able to satisfy them on that occasion. The Brighton Corporation had themselves obtained a provisional order, authorising them to light a specified limited area by means of electricity, but though they had tried the electric light in the Pavilion and other places, not included within that area, yet they had not as yet availed themselves of the power which was conferred upon them by that unrevoked order. Assuming that the Corporation had been anxious to be careful with the ratepayers' money, and that rightly or wrongly they regarded electric lighting as experimental, he did not desire to quarrel with them because they had not availed themselves of their order, nor would he accuse them of a "dog in the manger" policy. It was sufficient for him that the Corporation had themselves the power and had failed to avail themselves of it. The company which he represented desired no monopoly. The order they were applying for would provide that all new mains should be laid underground, but they asked that five years should be accorded them in which to remove the existing overhead wires. He desired to draw attention to the fact that the company would not be restricted to any particular system of lighting, but would be free to adopt any system which science might prove to be most advantageous both for the commercial and general community. According to clause 6 of the schedule, it would be found that the undertakers might supply electricity within the area of supply for all public and private purposes, provided it should be supplied subject to such regulations and conditions for securing the public safety and for ensuring a proper and sufficient supply of electricity as the Board of Trade might from time to time impose. The objections of the Hove Commissioners were almost confined to the clause stating that "the description of the proposed works was insufficient, and the provisions for securing the safety of the consumer and of the public inadequate." In reply to that objection, he pointed out that the company were under the orders of the Board of Trade from time to time. With regard to the gas company's objections, they had principally regard to clauses 11 and 12; but in those clauses the company were simply following the forms authorised by the Board of Trade. Having stated that the telephone company's objections had been met, counsel concluded by saying that the electric light

company would be prepared to bind themselves to a standard price fixed on a sliding scale, as in all new gas companies. Their only desire was to act in a fair commercial spirit, knowing that in satisfying the requirements of the town they were best consulting their own interests.

Mr. ROBERT HAMMOND, chairman of the Brighton and Hove Electric Light Company since its establishment in September, 1885, was then called. He explained that the company, on its formation, took over a concern which had been going for four years previously, so that house-to-house electric lighting had existed in Brighton since 1881. Witness spoke of the lighting operations of the company at the railway station, the principal hotels, and various private houses, and alluding to his own experience, said that he was managing director of the Eastbourne company, which supplied house-to-house electric lighting on the same system as that in vogue at Brighton. At Eastbourne the system had succeeded. He founded the Hastings company, which was a going concern, and also the house-to-house company which had just laid down a station at Kensington, which had been favourably reported upon by many scientific authorities. At present the Brighton company had no power to lay wires underground, and they desired to acquire that power as they believed that they could thereby effect a considerable improvement in their system. Over 20 miles of overhead wires existed in Brighton. The station of the company was in Gloucester Road. On November 6th they received a letter from the Board of Trade enclosing a report from Colonel Armstrong and asking whether the directors were prepared to take the necessary steps to comply with his suggestion. At the same time, the Board of Trade drew attention to the serious responsibility incurred by the company in supplying electricity under the system described in the report. The main objection which Colonel Armstrong offered to their overhead wire system was that they were not covered with proper insulating material, and in certain places they were not running parallel, and therefore did damage to the telephone company's wires by induction. Thereupon the directors communicated with the solicitors of the telephone company, and agreed to change their wires so as to prevent future induction. The objection referred to was thus completely removed. Witness continued that in the event of the powers they asked for being granted there would be no danger to the public in placing the wires underground. No one could then touch them, and even if they could be touched no danger would ensue, inasmuch as the wires would be properly insulated. Giving five years as the period they would take in removing all overhead wires, they gave the extreme limit, and would undertake to make the change in three years. The company were desirous more particularly of running their wires underground because they could use a thickness of cable otherwise impossible, and a better regulated light could be produced. During the past few years their price had been 1s. per Board of Trade unit. With the large increase of plant which they would be able to lay down if that order were granted they saw their way clear to a great reduction in prices, which they proposed to base according to a sliding scale of 1s. per unit, 9d. per unit, and 6d. per unit, so that clubs, hotels, and large consumers generally would get their electricity at something like 7d. per unit. Where the light was required over three hours a night it would be supplied on the 6d. scale, or at an alternative charge of 8d. per unit all round. Sixpence per unit was equivalent to about 4s. in gas, amount for amount of light. After seven years they proposed to limit their dividend, and at the expiration of that time, under the order, the price would be fixed by arbitration, based upon a 10 per cent. dividend, power being given for the increase of that dividend on every reduction in price. The system now in use by the company was the alternating current parallel transformer, which had worked well in Eastbourne and Kensington as well as Brighton, and which he considered perfectly safe. The Brighton Company had so far paid, though their standing charges had been enormous as compared with what they would be if they had larger plant and could supply a larger number of people. The same electrician could manage a place five or ten times as big as the present station. Notwithstanding these disadvantages they were the only electric supply company in the United Kingdom which had regularly paid a dividend from the commencement and put aside an adequate reserve for depreciation of plant. Before the company was formed an immense amount of money was spent in experiments which did not appear on the balance-sheet. Admitting that their light had not been perfect he attributed any defect to their works being so cramped. The demand in Brighton was, however, increasing to the extent of 41 per cent. per annum, while the increase last quarter, compared with the corresponding quarter of last year, was 81 per cent.

In cross-examination by Mr. BOXALL, witness said that no provision had been made in the Order for the appropriation of any specific sum by way of capital, nor was there provision for any deposit. They would, however, be pleased to insert clauses to that effect, and also a clause for revocation in case the capital was not subscribed in a given time. Up to January last the nominal capital was £25,000, but only £12,500 had been actually issued, and £3,100 of that was issued during 1888. Up to the end of 1887 15 miles of mains were open and they added over five miles during 1888. Although they gave notice of application for the Order in June last, they had continued to increase their overhead mains, not being certain that their application would be granted. The undertaking taken over on the formation of the present company was the Hammond Electric Lighting Company, of which he was founder and managing director. When it went into liquidation, he and others bought the Brighton branch for £2,000 and revalued it at £6,000 on issuing shares, as they considered that they had spent £4,000 on experiments. It was calculated that if they put down plant to supply 12,000 lights they would be able to meet the demands upon them during the first year and to increase their plant in accordance with their requirements. Witness had been connected with one company which went into liquidation and lost £12,000 in a sub-company, but no supply company he had started had been unsuccessful. Had not calculated what the cost of converting 12 miles of overhead mains into underground mains would be. They proposed to appropriate £25,000 of capital, but they would call up the remainder of their capital as circumstances demanded. They had a distinct plan for a new station but the site had not been purchased and he declined to mention the one they had in view. Witness further expressed his willingness to have a clause inserted revoking the powers given by the Order unless the whole of the capital was allocated and £50,000 subscribed during two years. They were, moreover, prepared to alter the price clauses, so that seven years hence their standard should not be higher than now.

Mr. ARTHUR WRIGHT, an engineer of the company, with which he had been connected since 1881, expressed his opinion that electric lighting in Brighton and Hove had passed into a practical, commercial stage. He considered that Brighton was, with the exception of London, the best town in England for the accommodation of the electric light. In his opinion, the price proposed by the company was, so far from being exorbitant, too reasonable.

Cross-examined by Mr. WALLACE, witness said that under the new Board of Trade restrictions he considered insulation would be as good underground as overhead. The laying of mains underground would not generate electricity.

Mr. WILLIAM LOWRIE, engineer of the Kensington Company, stated that he understood he was to be constructing engineer to the Brighton company, should they get the powers asked for. He had had charge of the constructing of the new works at Eastbourne, where the work had been carried out to the satisfaction of the Corporation. Since the middle of 1886 the transformer system had been in existence at Eastbourne, and the success it had achieved there led to its introduction at Brighton. As far as he could see, there was no reason why it should not work as well at Brighton as at Eastbourne. The more he saw of the system the better he liked it. He should say that the cost of substituting underground for overhead mains would be (for a thousand lights per mile) about £400 per mile for conduits. He believed the transformer system to be a safe one for Brighton.

Cross-examined by Mr. BOXALL: At Eastbourne and Hastings the mains were placed underground, without the assistance of a Provisional Order. At West Brompton they supplied about 500 lights. The cost of the mains and laying them down would average about £800 a mile. No difficulty had been experienced in finding places to put their mains in the streets of Hastings and Eastbourne. It was advisable to have the station as near the centre of the area to be supplied as possible.

In answer to Mr. WALLACE, witness said that the cost of producing electricity at Brompton was 3½d. to 4d. per unit, the system employed being the same as at Brighton. He would not require to go to a greater depth than 6 inches under the pavement to lay the mains.

Cross-examined by Mr. HOWLETT: There were a fair number of repairs at Eastbourne, owing to the fact that the cables there were put down at a time when little was known of electric lighting. The cables put down under the alternating system had not required repair. The company always used lead joints in laying down mains.

Re-examined: They had power at Kensington to supply 6,000 lights, though at present they only supplied 500.

Major-General KENYON STOWE, 31, Brunswick Terrace, Hove, spoke of the success of an installation at his residence.

Mr. LUNDY, manager of the Brighton Alhambra, said that they had about 300 lights, supplied by the Brighton Electric Light Company. The light was splendid, and the best he had ever seen at a place of public entertainment. It would, in his opinion, be a public benefit if the company obtained the powers they were asking for.

Cross-examined by Mr. BOXALL: He could not say whether it was the intention of the directors of the Alhambra to obtain their light in future from London. If they did so, it would be simply on account of the cost and certainly not on account of the quality.

Mr. PEAKE, 16, Belgrave Street, Kemp Town, said that he had seven lights supplied by the company which were in every respect excellent.

Prof. G. FORBES, having inspected some of the American installations, gave it as his opinion that electric lighting was not in an experimental stage. The central station system was admirably adapted for house-to-house lighting. The alternating current parallel converter system was almost universally adopted. In his opinion the company would have no difficulty in insulating 2,000 Volt currents, nor would there be any difficulty so far as continuity of lighting was concerned.

Mr. GEORGE HECKBURN, manager of the Bedford Hotel, Brighton, said that their installation had worked well, and was liked by the customers. The cost he had calculated at 1¾d. per light.

Mr. DAWSON, of Rashleigh, Phipps and Dawson, London, said that he considered there was plenty of scope in Brighton for electric lighting enterprise.

Mr. LAMETTE, proprietor of several large mansion boarding houses, also testified to the excellence of the company's installations.

Mr. ALFRED ROGERS, estate agent, proved that since the previous Monday afternoon 2,996 signatures had been obtained in favour of the electric light in Brighton and Hove.

The enquiry was then adjourned until Friday, when further evidence was called with reference to the obtaining of signatures, Mr. WILLS, Q.C., intimating that he had 1,900 more before him that morning.

Mr. BOXALL, addressing Major Marindin on behalf of the Corporation, pointed out that this was a case in which a company sought to obtain certain powers without the consent of the local authority, who were already themselves armed with those powers. The applicants evidently desired to supply a very wide area with very small capital. They came to that Court without any definite calculations, and had failed to show any prospect of financial success. Under those circumstances he failed to see why they should be granted an order which would enable them for 42 years to exercise a practical monopoly of the electric lighting of the town, and to maintain, for three years at any rate, the present unsafe system of overhead wires, and give them the right to break up the streets and roads, simply because they had already erected unsafe overhead wires. If, in the present instance, the Board of Trade granted the order, a very evil precedent would be afforded, and a temptation would be held out to companies to start with a very small system, and with very limited capital, in various towns, and having, in defiance of the local authorities, raised up overhead mains, go to the Board of Trade for power to break up the streets and roads as they pleased. Although the Brighton Company had started under exceptionally favourable circumstances, obtaining their plant, premises, and works at an enormous discount on their original cost, yet they could not in the third year show a dividend of more than 5 per cent. And when they came to analyse the balance-sheet it was seen that only 5 per cent. had been allowed for depreciation, and that a profit of £532 included £357 from wiring new premises which could not be expected to continue. He contended that at least 7½ per cent. should be allowed for depreciation, and allowing for that and deducting the £357 he had just alluded to, the balance-sheet would show a deficit of £100. Then, on Mr. Lowrie's estimate the cost of placing the twenty miles of overhead wires underground would be £16,000. How then could the company expect to pay a dividend in the future? This was a matter of great importance to the Corporation, who had a right to ask, "Is this going to be a permanent supply, or is it only going to be the sale of a valuable concession to a number of shareholders upon an increased capital and then a liquidation, or a user for the term of three years of the overhead wires without any honest attempt to replace them by underground mains—and then, perhaps, a break-up of the company?" He submitted that for three years the Corporation would have no power to require the company to lay a single underground main. The Corporation intended themselves to supply electricity so soon as they considered they could do so with advantage to the community, and in conclusion he said that they opposed the granting of the order, not only because they believed the company to be financially insecure, and because its scheme was impracticable, but because also it would confer a right to interfere with their property.

Mr. LOCKWOOD, consulting engineer to the Brighton Corporation, said that the corporation had been anxious for the last 10 years to do what they could in the matter of electric lighting, and to adopt it if it could be shown to be of advantage to do so. In 1881 the Marine Parade sea frontage was brilliantly illuminated by electricity for about two months. At that time estimates were received from Messrs. Siemens, and in 1882 a congress was held at Brighton, when the Pavilion and other places were supplied with the electric light by the branch company. In 1883 a Provisional Order having been obtained, a permanent installation was provided in the Pavilion at a cost of £2,700, there being 500 lights. In the following year 400 more lights were added, making the total installation 900 and the cost £5,045. In 1887 on the insulation being discovered to be imperfect the mains were relaid, under the direction of Mr. Preece, at a cost of £500 more. The system employed at the Pavilion was Siemens's, and it was now in working order. The Provisional Order obtained by the corporation would permit them to use any system they pleased. In his opinion as noise was most objectionable in Brighton, it would be better if the station were a mile or more away. The corporation had a very good place about that distance from the town which would serve admirably for a station in the event of its being decided to adopt electricity. It was very desirable that the corporation should have sole control of all pipes, &c., underground.

Cross-examined by Mr. WILLS: During the two years the order had been in existence they had not lighted a single inch of the specified area. He did not concur with the remark that electric lighting had gone beyond the experimental stage for house-to-house lighting.

The Hon. REGINALD BROUGHAM, electrical adviser to the Corporation, said that his experience in laying down mains was confined to London. He should say that Mr. Lowrie's estimate erred on the side of economy rather than on that of extravagance. Calculating 100,000 lights for Brighton, exclusive of Hove, the cost of plant would in his opinion, basing the calculation at £2 per lamp, amount to £200,000. Fifty miles of mains, which would be a fair estimate, at £800 per mile (Mr. Lowrie's estimate), would bring the amount for plant to £240,000. In his opinion 5 per cent. was an inadequate allowance for depreciation; 7½ per cent. all round would be a fair allowance.

Cross-examined by Mr. WILLS: He thought it quite possible for Brighton to be lighted by electricity, and believed people would take it. He did not consider house-to-house lighting to be in an experimental stage.

Mr. WALLACE then addressed the inspector on behalf of the Hove Commissioners, who had, he said, carefully considered the question of electric lighting, and had arrived at the opinion that they could not as yet adopt any particular system. They contended that the time was not yet ripe for the introduction of electric lighting into Hove, and that when the time did arrive they were the proper people to choose the best system and find the necessary capital.

Mr. G. B. WOODRUFF, Chairman of the Hove Commissioners, said that at present there was very little demand in Hove for the electric light, which had not given satisfaction on account of its flickering. The Hove Commissioners hoped in time to light the town by electricity themselves. The company's system of laying down street mains would be thoroughly bad for Hove.

Cross-examined by Mr. WILLS: He believed that the Commissioners would be able to supply the light cheaper than the company, because they would light the Town Hall and public streets. Until they had definitely decided which was the best system the Commissioners' Committee on Electric Lighting would not recommend to ask for a Provisional Order.

Mr. C. A. WOOLLEY, Clerk to the Hove Commissioners, and Mr. H. H. SCOTT, Borough Surveyor, also gave evidence.

Mr. J. W. HOWLETT, for the Brighton and Hove Gas Company, asked no questions of the witnesses, and Mr. WILLS then replied on behalf of the company, offering to make a deposit of £2,000 as a security for the stability of the company, and to have as much capital subscribed as the Board of Trade should demand. As to site, any new station should be subject to the approval of the Board of Trade. It was clear that house-to-house electric lighting had passed beyond its experimental stage, but if there was any risk it would be better that a private company should run it. He repeated that the company were tied down to no system, and, if the Order were granted, would bind themselves to proceed with all reasonable dispatch in removing the overhead wires.

This terminated the enquiry, and the inspector intimated that he would make his report to the Board of Trade in due course.

NEW PATENTS—1889.

5563. "Improvements in electric batteries." H. H. LAKE. (Communicated by Lacombe & Co., France.) Dated April 1.

5612. "Improvements relating to the distribution of electric currents, and to apparatus therefor." H. H. LAKE. (Communicated by E. W. Rice, Jun., United States.) Dated April 2. (*Complete.*)

5615. "Improvements in the generation of electricity on railway trains." I. A. TIMMIS. Dated April 2.

5621. "Improvements in and relating to electric induction coils or transformers." H. H. LAKE. (Communicated by E. Thomson, United States.) Dated April 2. (*Complete.*)

5623. "Improvements in and connected with telegraphic apparatus for transmitting orders or other communications." G. A. CALVERT. Dated April 2.

5640. "Improvements in or relating to electric railway signals." A. J. BOULT. (Communicated by W. H. Waddell, United States.) Dated April 2. (*Complete.*)

5656. "A novel arrangement for conducting an electric current through the nose." H. WELCKER. Dated April 2.

5676. "Improvements in electric bells." D. REID and J. KEAN. Dated April 3.

5738. "Improvements in and connected with insulators for electric light and other wires." A. W. FITCH. (Communicated by R. O. G. Drummond, South Africa.) Dated April 3.

5740. "Voltaic electric belt made with zinc and copper strips united to each other, to fit any part of wearer." J. WOOD. Dated April 4.

5768. "Improvements in wooden casings for electrical conductors." W. G. DE F. GARLAND. Dated April 4.

5816. "Improvements in electrical accumulator or secondary batteries." W. E. LANGDON. Dated April 5.

5832. "Improvements in electricity meters of the pendulum class, parts of such improvements being applicable to other kinds of electricity meters." G. HOOKHAM. Dated April 5.

5839. "Improvements in dynamo-electric machines." T. H. ALLUM, G. C. FRICKER and J. R. BAINTON. Dated April 5.

5844. "Improvements in protecting telegraph, telephone, electric lighting and other installations and instruments from damage by lightning or other high tension electric currents, and in apparatus therefor." O. J. LODGE. Dated April 5.

5867. "Improvements in connection with switches for telephone circuits." A. GRAHAM. Dated April 5.

5888. "Improvements in methods of measuring electric resistance." A. P. TROTTER. Dated April 6.

5894. "Conveying electricity or communicating with light vessels by electricity." W. E. BLACKBURNE. Dated April 6.

5904. "Improved means and apparatus for electrically communicating between trains and fixed points or stations." W. W. POPPLEWELL. (Communicated by F. Lefrçanois, E. Manborgne and O. Boin, France.) Dated April 6.

5912. "Improvements in systems of suspending electric conductors" C. J. VAN DEPOELE. Dated April 6. (*Complete.*) [Date applied for under Section 103 of the Patents Act, 1883, 10th September, 1888, being date of application in the United States.]

5913. "Improvements in devices for establishing electrical contact in electric railways." C. J. VAN DEPOELE. Dated April 6. (*Complete.*) [Date applied for under Section 103 of the Patents Act, 1883, 7th September, 1888, being date of application in the United States.

ABSTRACTS
OF PUBLISHED SPECIFICATIONS, 1888.

1926. "A mechanical chair or seat for the delivery of a current of electricity upon the insertion of a coin." H. C. BRAUN and A. F. LLOYD. Dated February 8. 8d. Consists of a chair or seat having metal arms, handles, or knobs, which are employed as conductors of electricity, which electricity is generated by either a galvanic battery or a magnetic apparatus, contained in the space under the seat of, or at the back of, the said seat or chair. The claims are 6 in number.

2313. "Improvements in dynamo-electrical machines." S. Z. DE FERRANTI. Dated February 15. 11d. The inventor forms the armature with conducting coils radiating from its circumference, and uses fixed magnets on either side of it, as in machines described in the specifications of former patents granted to him, and those parts of the armature coils which pass across the magnetic field between the fixed magnets he forms of iron, so that but little force may be expended for magnetising, and a suitable field so obtained for being magnetised alternately in different directions. Those portions of the armature coils which do not pass between the magnets, but which extend either outwards or inwards beyond them, he forms of copper or other non-magnetic conductor, so that the magnetic circuit is not continuous throughout the conductor in the direction of the flow of current through it. The central space of each armature coil he also fills in with iron plates, so that the magnetic field remains continuous of uniform power across all parts of the circle of armature coils. The claims are 10 in number.

2313A. "Improved means for obtaining a uniform continuous current from dynamo-electrical machines." S. ZIANI DE FERRANTI. Dated February 15. 8d. When a dynamo-electrical machine for producing an alternating current is worked with a commutating device for directing the current, the continuous current obtained, although in one direction, is not uniform in strength. Such a current is not suitable for working motor engines. To remedy this the inventor uses a self-induction coil with single circuit coupled in parallel across the mains, or he uses a condenser with the mains to obtain the same result. In this way a uniform continuous current may be obtained, applicable not only for supplying electrical motors, but also for charging batteries and for like uses, wherever a uniform continuous current is required.

2314. "Improvements in electrical safety fuses." S. ZIANI DE FERRANTI. Dated February 15. 8d. The inventor makes the casing by which the fuse wire is surrounded to fit to the wire at one or more points of its length, whilst open spaces are left between the wire and the sides of the cases at the remaining parts of its length, so that the conducting particles of the fused wire may be dispersed. Or discs of asbestos, or like insulating material, may be placed at intervals across the interior of the casing, and the wire made to pass through them, or a single disc might be used. The claims are 3 in number.

2315. "Improvements in electrical mains." S. Z. DE FERRANTI. Dated February 15. 8d. The inventor forms each conductor as a flexible cable composed of a number of thinly insulated wires of comparatively small diameter with insulating material surrounding the whole assemblage of wires, or he makes each conductor of two or more concentric tubes drawn one over the other with thin insulating material between them, and where each electrical main is formed with a return tubular conductor, as described in the specification of a patent granted to him, No. 15,251, in the year 1885, he in addition to forming each conductor of a metallic tube draws one over the other with thick insulating material between the two, now forms each tubular conductor of two or more tubes similarly drawn one over the other, but with comparatively thin insulation between them. The claims are 5 in number.

2316. "Improvements in dynamo-electrical machines and apparatus used in connection therewith." S. Z. DE FERRANTI. Dated February 15. 2s. The improvements have mainly for their object to enable dynamo-electrical machines to be so constructed that currents of very high tension may be produced by them. The armature coils or bobbins the inventor insulates and holds in place by a fusible cement—preferably sulphur cement. He does this by holding the bobbins or coils in metal shoes, each of which has a radial stem projecting from it at the back. The claims are 29 in number.

2420. "An improved method and apparatus for effecting the regulation of electrical currents." W. H. SCOTT and E. A. PARIS. Dated February 17. 8d. The inventors combine two dynamo-electric machines, coupling the armatures together, one of the machines being arranged to act as a generator and the other as a regulating motor. The armature and the field magnets of the motor dynamo are placed in series in the main current from the generator, only a few turns of wire being applied to the motor field magnets, just sufficient to start the armatures and to keep them running at a certain speed when there is no current in the outside circuit of the generator. The claims are 3 in number.

2654. "Improvements in the regulation and control of dynamo-electric machines and in apparatus therefor." J. A. KINGDON. Dated February 22. 8d. Relates partly to the improved dynamo-electric machine which forms the subject of letters patent No. 15,837 of 1886, and in which the conducting wire both of the field or primary magnets and also of the secondary magnets is fixed. The claims are 6 in number.

3550. "An electrical battery." N. G. THOMPSON. Dated March 8. 6d. Claims:—1. Employing carbon in combination with a metal as a negative agent in a voltaic cell, the metal being electro positive to carbon and subject to the action of chlorine as specially described, so that a chloride of that metal is continuously being formed, for the purposes set forth and in the manner specified. 2. The use of a distributed conductor throughout the crushed carbon, for the purposes set forth and as substantially described.

3618. "Improvements in fire alarm telegraphs." H. A. C. SAUNDERS and A. C. BROWN. Dated March 8. 8d. The improvements are designed to fulfil the following conditions found necessary in the actual working of such apparatus:—1. To give an effective call, irrespective of the caller's actions with the knob, after he has once pulled. 2. To keep the line under continual test for contacts, &c., but to make a distinction between rings arising from such causes and real calls from the call-point. 3. To enable replies to be sent in answer to the calls, and conventional signals to be sent by the firemen both from and to the posts, without requiring any batteries in the posts. The claims are 6 in number.

4425. "Improvements in dynamo-electric machines or motors." P. J. CHARLES, L. HANSON, and R. H. FOWLER. Dated March 22. 8d. The inventors use, instead of the low resistance wire helix, a sheet or sheets of metal of the required sectional area, wound around the iron core in the form of a roll, each convolution of which covers the entire length of the core or limb of the magnet. The claims are 2 in number.

5082. "Electricity meters." R. P. SELLON and R. C. JACKSON. Dated April 5. 8d. The inventors actuate indicators and registers or recorders by action due to the gas or gases resulting from the electrolysis of liquid by the current or part of the current to be metered, and periodically exploding the resulting gas or gases, or permitting the escape thereof. The pressure of the gas or gases is utilised to give motion to an indicator and register or recorder, which may be effected by any suitable device, such, for example, as by a piston or float, or by closing electric circuits to actuate electro-magnetic devices. The claims are 5 in number.

5259. "Improvements in electrically heating rooms, buildings, and the like." J. V. CAPEK. Dated April 9. 8d. Claims:—1. Electrically heating rooms, buildings, and the like, by means of thin widely-spread electrical conducting bodies, such as adherent coatings of carbons applied to non-electrical conducting surfaces and placed upon the walls of a room or in other convenient situations, the electric current being passed through the whole coating with uniformity, and the resistance and radiating surface of the coating being so proportioned to the current that such coating is heated at every part to a uniform temperature, which is lower than the igniting point of wood, paper or like combustible materials, whether the coating is or is not provided with a protecting covering, substantially as described. 2. Electrically heating rooms, buildings, and the like, by means of strips or pieces of combustible material such as wood or paper, covered with coatings of electrical conducting material, through which the electric current is passed, the resistance and radiating surface of the coating being so proportioned to the current that such coating is heated to a temperature below the igniting point of the combustible material on which it is placed, substantially as described.

5528. "An improvement in plates for voltaic batteries." E. H. E. J. PATERSON and C. F. COOPER. Dated April 13. 4d. Claim:—The construction of plates for voltaic batteries employed for electrolytic or other purposes, by drawing metal into fine wires, weaving them into gauze, and supporting sheets of this gauze in insulating frames with a conductor cast, soldered or otherwise metallically connected to the gauze, substantially as described.

6270. "Improvements in clips for attaching or fixing Insulators to telegraph poles." H. C. JOBSON. Dated April 27. 8d. In clips for attaching or fixing insulators to telegraph poles as ordinarily constructed one end of each clip of the pair of clips is provided with a boss in a hole in which the lower end of the stalk carrying the insulator or the bolt carrying or holding the shackle straps is inserted and fixed. In constructing a clip according to the invention the inventor makes it, as usual, in two halves. He

extends preferably by forging one end of the half clip so as to form a horizontal arm, the outer end of which being turned up at right angles form, forms the stalk to the top of which the insulator is affixed. Two of the said half clips which are identical in form and size are connected together by screw bolts and nuts so that the stalks for receiving the insulators are symmetrically situated on each side of the body of the clip. The two half clips are made to grip, and are thereby fixed to the telegraph pole by means of screw bolts and nuts. There is 1 claim.

13145. "Improvements in incandescent electric lamps." E. BOHM. Dated September 11. 8d. The inventor forms around the globe or bulb containing the carbon or other filament an envelope or outer globe or casing, and he fills the intermediate spaces between the outer and inner globes with water or other suitable liquid. The claims are 3 in number.

16959. "Improvements in automatic electric contact apparatus." C. F. HILKIER. Dated November 21. 8d. Claims:—1. In automatic electrical contact apparatus and electric conducting hermetically closed receptacle with one or more resilient walls adapted to be moved by the pressure or vacuum in said receptacle caused respectively by the effects of rise or fall of temperature on a suitable liquid or fluid in said receptacle, substantially as and for the purpose described. 2. The combination with said receptacle of a hand pressure button upon one of the walls thereof, substantially as set forth. 3. The special construction substantially as described and illustrated with reference to the drawings.

18245. "Improvements in electric lamps or lighting apparatus." C. COERPER. Dated December 14. 8d. The subject of this invention is an electric arc lamp which can be operated either by alternating currents or by a continuous current. The claims are 8 in number.

18416. "Improvements in apparatus for measuring currents of electricity." M. J. R. JACQUEMIER. Dated December 17. 1s. 8d. Relates to electrical meters of the kind described in a former specification, No. 14,226, of 1887, and consists in modifications and improvements on such meters. The claims are 21 in number.

CORRESPONDENCE.

Some Electric Lighting Central Stations in Europe and their Lessons.

Having read in Nos. 589 and 590 of your esteemed journal the reproduction of Prof. Forbes's interesting lecture before the Institution of Electrical Engineers, we beg you to allow us an opportunity of amending some of his statements, feeling that we are called upon to do so, if alone for the reason that, perhaps owing to their inadequacy, he has interpreted wrongly some details of our system which, at his request, we forwarded to him.

In that part of the lecture where he describes our transformers we find the following sentence:—"These (the flat ring-shaped discs of iron) are firmly clamped together by iron clamps, which form the support of the instrument." (Page 315.) We amend this description, in as far as the clamps which hold the induction coils between the upper and lower iron plates are not of iron, but of well varnished wood, for the purpose of lessening the chances of short-circuiting taking place through the frame.

When speaking of the automatic regulator by our Mr. Bláthy, Prof. Forbes says:—"The exciting current passes through a solenoid actuating an iron rod which, &c." (Page 315.) By "exciting current" here is meant, not the current which goes to excite the magnets of the dynamos, but a current derived from the main leads, and then transformed for actuating the automatic regulator and a voltmeter. The current for the magnetisation of the exciting dynamos passes through the resistances, of which the number in circuit is varied by the action of the solenoid.

In the paragraph on transformers Prof. Forbes says:—"I have elsewhere described the Westinghouse converter, which I have tested and found to be very efficient, even though the largest one he is in the habit of supplying is only for 40 lights.

"Only the larger size of Zipernowsky converter is so efficient. Three sizes are made, varying in efficiency from 95 down to 88 per cent., though the latter is a converter suitable for 25 lamps." The actual figures for the efficiency of the Westinghouse transformers are not mentioned, being only described as being "very efficient." Moreover, the figures given as the efficiencies of our transformers are not what have been found from tests made by ourselves and others. The three sizes, the larger of which we find to be the most suitable for lighting purposes, have efficiencies varying from 95·5 down to 92·5 per cent.; not as stated by Prof. Forbes from 95 down to 88 per cent.

As glad as we may be to see that Prof. Forbes recognises in the lately patented alternating dynamo by Messrs. Elwell-Parker & Co. our oldest form with wooden cores in the armature coils, we do not share his views about the advantages offered by an internally revolving armature. Firstly, we do not see why a field magnet wheel may not be so easily and well balanced as an armature. He himself allows that our field magnets are very well balanced. Secondly, we must dispute the assertion that the armature coils of the Westinghouse machine can better withstand centrifugal strains than those of our machines. Each coil of the Westinghouse armature is simply laid on to the bare drum, covered with sheets of mica, and held in position by bands of wire passing round the armature. On the other hand the magnet coils of our machines are wound on zinc bobbins, slid on to the magnet limbs, and held in position by strong bobbin holders of bronze, which are again secured by bolts passing through the magnet poles. This arrangement is at least firm and to the purpose. It cannot be denied that coils which are for the purpose of producing currents of high tension can be insulated and mounted with more ease when intended to remain fixed than if meant for rotation. There is still another advantage in this feature of our machines, and that is, that each armature coil may be separately taken out and replaced independently of the others, which, with the Westinghouse machine, is not possible. Repairs can, for these reasons, be made comfortably and quickly, the necessary reserve being wieldy and cheap, viz., one or two spare armature coils, against, as necessary for the Westinghouse, a complete armature.

It is therefore not considerations of strength which deter us from running our machines at high speeds, but the low number of alternations chosen by us (5,000 per min.), and not that, as assumed by Prof. Forbes, we determine the number of alternations from the number of revolutions. Although for this reason we are in a position to run our machines in parallel, this is not a subordinate result, but just what was aimed at. The argument brought forward by Prof. Forbes against running the alternating machines in parallel does not convince us, for the cutting out of each or any district is just as much able to be effected with the machines in parallel as when running independently, seeing that the leads for each district can be branched off in the central station. An example of this was seen by Prof. Forbes in Rome, where six feeders are fed from dynamos running in parallel. The same holds good concerning the increase in the resistance of leads carrying alternating currents; besides that, this increase is quite unimportant in our installations, because of the slow alternations and small section of the conductors. The employment of alternating dynamos in parallel does not therefore necessarily imply the use of one main lead. If other makers of alternating current machinery do not run their machines in parallel, their reason for not doing so is not because they hold it to be unsuitable, but lies elsewhere.

The introduction of a large amount of self-induction does not absolutely necessitate a diminution of the plant efficiency, as the increase of self-induction may be attained not alone by an increase of dimensions, but also by a change in the principles of construction. In order to maintain the pressure in such machines constant, it is certainly necessary to vary the exciting current within wider limits, than for machines with less self-induction. For the present we are of opinion that the difficulties remain the same, it matters not if the self-induction be great or small; that ours is the best solution amongst the methods of regulation known to him, Prof. Forbes has stated.

As far as the cost of the transformers is concerned, a low number of alternations causes an increase, which, however, is unimportant, notwithstanding that the transformers make up a considerable item in the total cost of an installation. In one word, the disadvantages of using allow number of alternations are so few and unimportant that they are quite outweighed by the advantages.

In conclusion, we must express our surprise that Prof. Forbes several times coupled the names of Messrs. Gaulard and Gibbs with converters put in parallel. We would point back to a lecture given by Prof. Forbes on the 19th February, 1886, nearly a year after our first demonstration of the parallel system in the National Exhibition at Budapest. In this lecture he represented *the Gaulard and Gibbs system of series connection as being the only right one, while at the same time he declared the parallel system to be impracticable.* It was not until much later, and after we had carried out several installations, that Messrs. Gaulard and Gibbs first saw that it would be impossible to keep the secondary tension of transformers in series constant. If the series system be named the Gaulard and Gibbs system, because they were the first to carry it out on a large scale, it would be at least just that the parallel system be named after those who have not only carried it out for the first time, but have proved its usefulness by many examples. We ask you kindly to publish this letter in the next issue of your valuable journal, and are

Ganz & Co.,
Per ZIPERNOWSKY.

April 13*th*, 1889.

Northfleet Series Tramway.

As Mr. Manville has seen fit to send you his reply to my letter to the *Engineer*, I must ask you to insert also my rejoinder, a copy of which is enclosed herewith.

For my part, I had not thought it worth while to write to the ELECTRICAL REVIEW, appealing as it does entirely to electrical engineers, who could form their own opinion as to the value of such figures as those given in connection with the Northfleet Series Tramway.

Wilfrid L. Spence.

Winterfield, Higher Broughton.
April 15*th*, 1889.

Sir,—Mr. Manville, in your issue of the 12th inst., says he cannot allow that more than 200 volts is safe as a working pressure for the parallel system.

Well, so much the worse for the facts, or for Mr. Manville, which? Certainly no tramway of any size, either in Europe or in America, is worked at so low a potential. On the other hand, several have been in successful operation for many years at from 250 to 300 volts.

A certain tramway is referred to—doubtless Blackpool. There is no need to refrain from mentioning it, for experience had to be gained somewhere, and others are now reaping the benefits of instruction from its early failures. But Mr. Manville is surely not labouring under the impression that the double bare copper conductors are used as positive and negative leads, with the full pressure between them. Such is not the case, the earth being used as a return. These conductors are, however, working very successfully at present.

The Series Traction Syndicate now admits, for the first time, that a very high pressure is intended to be employed, no less than 2,000 volts, and that the fanciful efficiency represented by a loss of 5 H.P. out of 405 H.P. on a five mile tramway was only on paper, in other words, the figures were taken as setting the series system in the best possible—and the parallel arrangement in the very worst—light. Hardly fair.

I am next taxed with unfairness myself in not placing the generating stations of both systems at the centre of the line.

I did not calculate on the series plant being so placed because I credited it with being a truly series system, and the advocates of such a plan must be aware that no economy whatever is effected by a particular position of the generators, hence I did not waste paper and ink by saying anything about it.

The resistance they have to overcome, in any case, is that due to twice the length of the line.

Now, by having a veritable central station, on the parallel system, the loss by resistance is just one quarter of the amount wasted if the generating plant is at one end of the line, consequently this system reaps considerable benefit from a central station, but the series system gains nothing from a similar arrangement, and this in fact is one of its advantages—allowing the dynamos to be placed anywhere on the line.

The relative resistances to be overcome, expressed as lengths of the line, are, for the series and parallel methods respectively, as 2 : ¼, or 4 to 1.

Mr. Manville then says that in some of our largest tramway plants such a position for the generating machinery would mean no less than 10 or 12 different stations. Even if it did, which is unlikely, a 400 H.P. unit is capable of being very economically worked, and although certain advantages would undoubtedly accrue from gathering all the machinery under one roof, yet the subdivision plan would in the end prove to be the better of the two, bringing with it decreased loss in conductors, and increased safety from a general breakdown. At the same time, it must be freely acknowledged that the series plan admits of one station supplying a whole system of lines, provided they converge to the centre of a town. But it does not admit of working on a purely series arrangement, for, adopting Mr. Manville's idea of a large system, this would mean a current of $\frac{400 \times 12 \times 746}{2{,}000} = 1{,}800$ ampères (nearly), traversing a distance of $10 \times 12 = 120$ miles, which, even with the 3-ton conductor, involves a loss of H.P. represented by 5 figures. This, of course, is not to be thought of, as to keep the E.M.F. down to 2,000 volts, the different sections are to be worked in parallel, or, to put it differently, this pseudo-series system is nothing but a parallel method under a different name, the only variation being that the ordinary parallel system works at, say, 400 volts, while the new arrangement takes 2,000 volts.

Mr. Manville next cavils with me for neglecting the return earth resistance; a very slight acquaintance with any parallel tramway plant would have convinced him of the error of such an accusation.

If he will turn to p. 205, Vol. 91, of the minutes of Proceedings of the Inst. C.E., he will see it stated that the conductor resistance of the Bessbrook and Newry Tramway is 0·221 ohm per mile, and that the total circuit resistance, allowing for faulty joints, &c., is only 0·250 ohm per mile. Further, it will be seen that the earth was not then used as a return, owing to the rails being insulated by the sleepers, whereas had the line been well earthed the resistance would probably have been lower still.

I claim, then, that the inclusion of the earth resistance not only does not affect the calculation materially, but does not even alter it appreciably. Mr. Manville's statement that "112 H.P. is no less that 28 per cent. of the total energy delivered to the conductors" is therefore erroneous both in fact and figure, for of course 112 H.P. out of 512 H.P. is not 28 per cent., but only about 22 per cent.

Lastly, with regard to danger, compensation, &c.

I did certainly suggest that linemen could work on a 400-volt circuit, and that repairs could be executed without stoppage of the dynamos, and that without any risk to the men; this is not equally possible on a 2,000 volt circuit, and, in fact, Mr. Manville seems aghast at the mere suggestion.

Mr. Spence has also "thought of the difference in maintenance of electrical machinery between series and parallel running." He knows from experience how much easier it is to maintain a constant potential than a constant current on a circuit of varying resistance; he is also aware of the small number of repairs required by shunt wound and comparatively low pressure dynamos, as compared with the number required by high potential series wound machines.

Again, it is obvious that an armature cannot be burned out with a constant current of normal strength, but other things can happen: for instance, the brushes might possibly be lifted by a sudden jerk, and then what occurs? The full electromotive force of the system—2,000 volts—is brought to bear on the insulation of a motor intended for only 50 volts; this is an endeavour, most likely successful, to force the normal current through. Result—work for the repairing shops.

"The infallible result of putting the low resistance armature of a motor suddenly across conductors with a difference of potential of 400 volts between them" I can also imagine, but not being very enthusiastic over fireworks I have never tried it, nor have I ever seen anyone else do the same, for such is not "in the power of any careless driver to do." The switch is always so arranged that the potential across the armature terminals can only be gradually raised.

As Mr. Manville seems to have information as to the number of armatures burned up in Richmond, Va., perhaps he will publish the same. Many others besides myself would be glad to know the number of failures and the cause of them.

But he must please give it as a percentage, for 30 or 40 cars are running there to his two at Northfleet.

A return of worn out or broken spring jacks, arrows, armature repairs—both motor and generator—and new commutators, &c., from Northfleet would also be interesting, in, say, a couple of months.

WILFRID L. SPENCE.

April 15*th*, 1889.

J. P. CHRYSTAL, Glasgow.—A reply to your letter was sent per post but returned marked "insufficient address."